The Growth Shapers

The Impacts of Infrastructure Investments

Prepared for the Council on Environmental Quality

May 1976

Other CEQ Land Use Publications

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In Preparation:

Leisure homes and recreational properties
Land use impacts of federal taxes
Energy consumption and land use
Land use inside cities
Costs of metropolitan development patterns

The Growth Shapers

The Land Use Impacts of Infrastructure Investments

Prepared for the Council on Environmental Quality
by Urban Systems Research & Engineering, Inc.
May 1976

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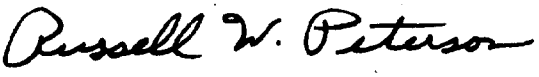
Preface

As part of its continuing analysis of land use issues, the Council on Environmental Quality is pleased to publish this handbook on the land use impacts of infrastructure investments.

As documented in another recent CEQ-funded study, *The Costs of Sprawl*, the pattern of land development has a substantial impact on the resulting environmental, economic, natural resource, and social costs. And as has been pointed out in numerous publications, including the chapter on land use in our 1974 Annual Report, public works investments are major determinants of land use patterns.

This is an issue the CEQ believes should be given much greater attention, particularly in terms of those investments substantially subsidized by the Federal Government. Federal monies fund 90 percent of interstate highway construction, up to 80 percent of mass transit investments, 75 percent of the cost of interceptor sewers and treatment plants, and 70 percent of non-interstate highways. All of these, as pointed out in this handbook, have substantial impacts on the location, pattern, timing, and density of development. We believe that these impacts should be recognized by project planners, local officials, and the concerned public, and that they should be carefully analyzed in the impact statements and other environmental analyses prepared for the projects. This handbook and other research CEQ is sponsoring on secondary effects is designed to help attain this goal.



Russell W. Peterson

Chairman
Council on Environmental Quality

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Introduction

This book examines the major role which many public facilities, termed "infrastructure" investments, play in the local development process. It covers such facilities as water and wastewater systems, power supplies, highway and secondary road networks, mass transit systems, and airports. Such investments affect local growth by influencing the location and costs of new construction, and can have a powerful effect on the density, timing, and amount of new development.

For example, the route of a new highway may lie near a tract of open farmland, putting that farmland within commuting distance of a city. The land soon becomes developed with single family housing because the new highway makes it into a suitable residential location. Similarly, a sewer built on undeveloped land relieves developers of the costs of providing wastewater treatment, and makes housing cheaper to build. Subdivisions are laid out near the new sewer because potential builders' profits are higher there. In both cases, growth seems to be created by the installation of new infrastructure; actually, the infrastructure merely concentrates growth which might otherwise have been located elsewhere in the region.

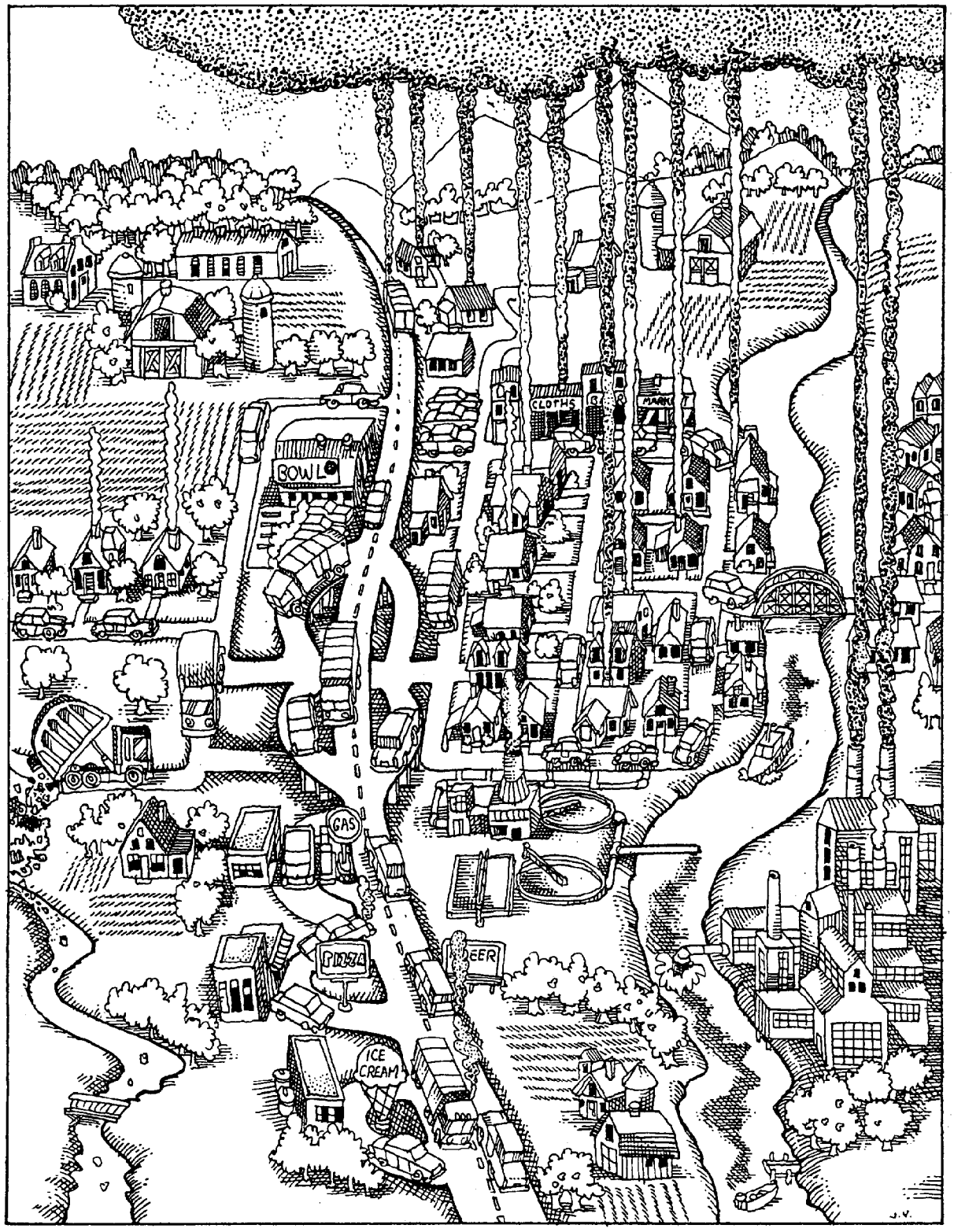
The careful design and construction of infrastructure can help achieve well organized, environmentally sound urban growth. However, infrastructure planners do not usually consider the land use effects of the investments. As a result, its construction often leads to unplanned land use changes that can result in major economic and environmental impacts.

The pace and pattern of development greatly affect a community's ability to accommodate growth without strain. Rapid, unplanned growth is often economically inefficient and environmentally destructive. Development may occur at densities and in locations which defeat long term community goals. Schools and municipal services must be hastily provided, and local tax rates are forced up. Haphazard, ill-planned subdivisions and shopping centers degrade the local environment.

The last quarter of this century is likely to see continued urban growth and continued suburbanization converting rural land to residential subdivisions. But new trends are emerging. Changing consumer preferences, rising housing prices, and national resource shortages are encouraging the development of more clustered and higher density communities. It is important that infrastructure investments be designed to enhance the positive features of new trends in development. At the least, local decision-makers should be aware of the land use implications of their infrastructure investment decisions, and the economic and environmental impacts likely to follow.

The link between infrastructure investments and land use changes has long been recognized in a general way, but little has been done to control the design and location of new infrastructure. Instead, the tactic has been to attempt to reduce the negative impacts of unplanned growth with tools such as zoning, subdivision controls, and local planning. These techniques often fail, particularly when land use is changing rapidly, as it often does following construction of new infrastructure. Changing the design of the infrastructure itself can be an effective additional control method, reinforcing the effectiveness of the other land use controls.

This handbook is intended to improve understanding of the link between infrastructure and land use. Local elected officials need to know what land use changes an infrastructure investment will provoke in their community, and what the impacts of these changes will


BOWL
CLOTHS
GAS
PIZZA
BEER
ICE CREAM

be. Designers of the investments must be concerned with the secondary impacts of their facilities. Developers should look at induced land use, both to see the real advantages of the infrastructure investment to them, and to help minimize the adverse impacts of their projects.

This book will provide the concepts and practical suggestions for making these decisions. Chapter 1 discusses the general interactions of infrastructure and land use, provides a practical framework for forecasting these interactions, and describes methods for controlling secondary effects. Chapters 2, 3, and 4, apply this framework to the analysis of three important types of public investments: highways, mass transit facilities, and sewers. Finally, Chapter 5 broadens the perspective of the book to include consideration of airports, major employment centers, recreational areas, flood control dams, and other developments which can also have powerful local land use effects.

1 The Problem

The use of land is perhaps the most basic of all environmental issues. Sound land use is fundamental both to preserving stable ecosystems and to controlling pollution, and even if such environmental issues seem remote to the daily problems of local governments, officials recognize the fundamental economic and social importance of proper land use.

The construction of new highways, mass transit lines, sewers, and other infrastructure can have a powerful effect on local land use. For example, most people are familiar with how the Interstate Highway System has speeded urban growth in the suburbs. The economic and environmental impacts of development induced by new infrastructure are of growing concern on all levels of government, for the direct local benefits provided by infrastructure may be seriously reduced or even outweighed by indirect impacts resulting from changes in local land use.

These impacts are extensive and often significant. Most represent real costs to the community — costs that may be reduced by proper land use controls and by infrastructure planning. Others may not be felt directly by the communities in which the growth occurs, but they are felt somewhere, and the responsibility for abating them remains important.

In the following pages, the impacts of land use changes resulting from infrastructure investments will be discussed. This will form a background for later parts of the book, which consider the process by which land use changes occur and procedures for forecasting land use changes associated with particular infrastructure investments.

The Impacts of Induced Development

Unplanned development can have serious economic, social, and environmental impacts on communities. The impacts vary according to how much development occurs, the spatial pattern and density in which it emerges, the speed at which it progresses, and the natural characteristics of the site. This section first reviews the major impacts associated with new residential development, with particular attention to its distribution and pattern, and then comments on commercial and industrial development.

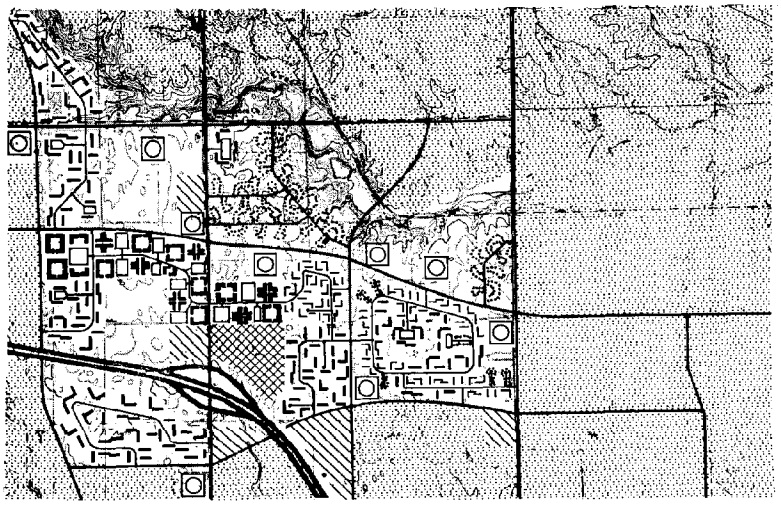
Economic Impacts of Residential Development

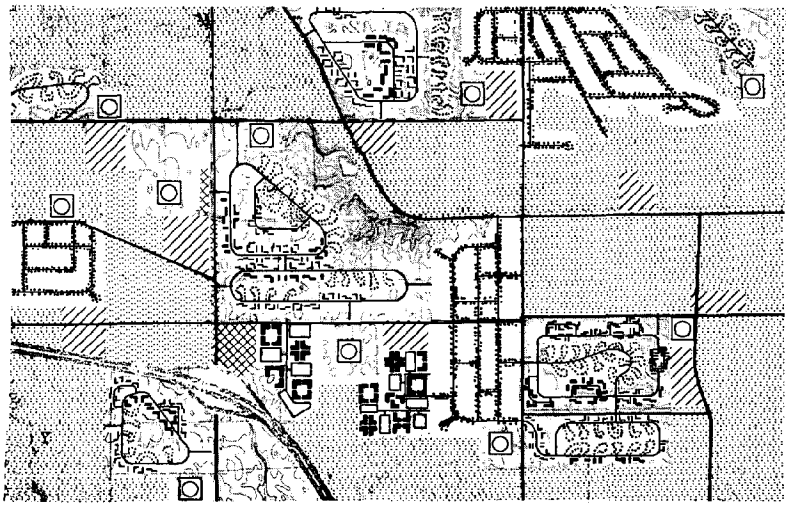
Economic impacts of development are separated into costs that are privately borne and costs paid by the government. The private costs of development depend primarily on the type of dwelling unit and the amount of amenities provided by the developer. In general, single-family housing is much more expensive in its capital and operating costs than multi-family housing. But, except for the problem of whether the community will contain sufficient medium and low cost housing, the private costs of different development types do not concern municipal governments — consumers have every right to pay for the amenities they desire.

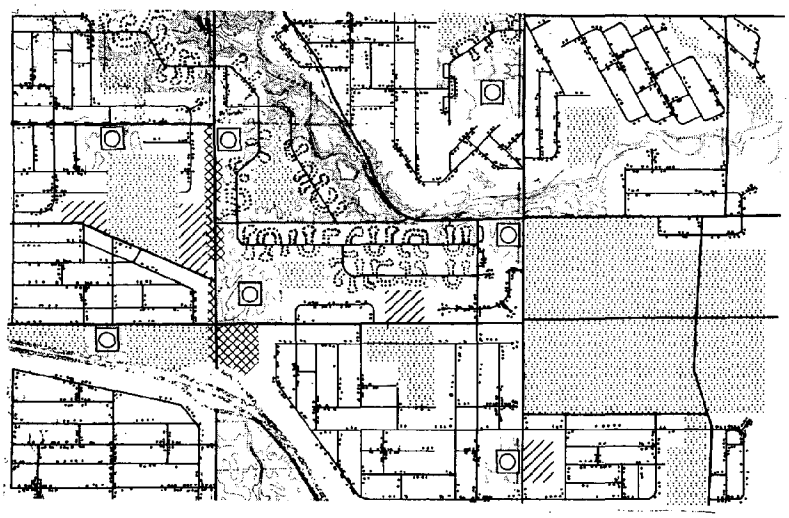
Local governments do, however, have a legitimate concern regarding the public costs and revenue generated by a new development, and may wish to control the amount, location, or pattern of development, so that it does not severely strain municipal finances.

A recent study of the average costs of different development patterns showed that sprawl development — the low density unplanned "suburbia" familiar across the country — is signifi-

(opposite) Adapted from *The Costs of Sprawl* by Real Estate Research Corporation, subsequently referred to as RERC. (All illustrations are by Urban Systems Research and Engineering, Inc., unless otherwise noted.)







COMMUNITY PROTOTYPES – LEGEND

VACANT LAND

PUBLIC FACILITIES

COMMERCIAL LAND

RECREATION AND OPEN SPACE

SCHOOLS

SINGLE FAMILY CONVENTIONAL

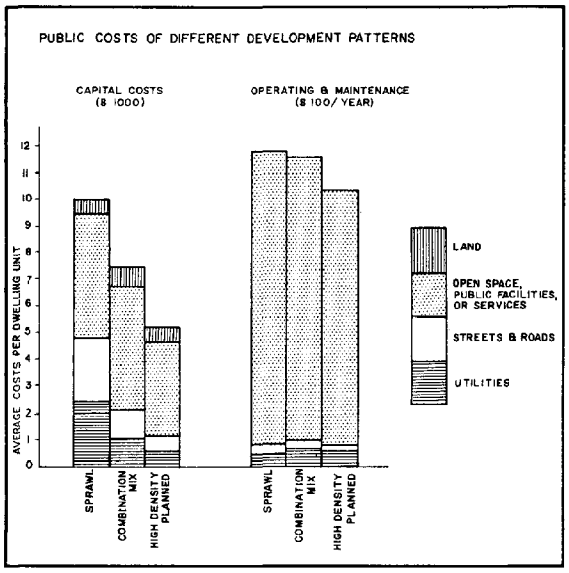
SINGLE FAMILY CLUSTERED

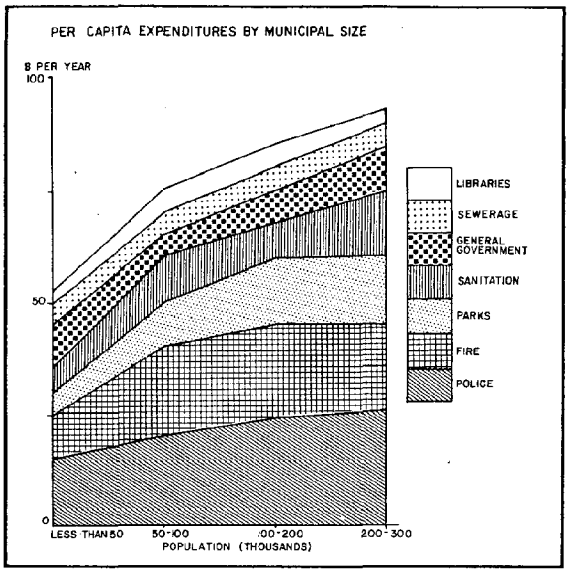
TOWNHOUSES CLUSTERED

WALK-UP APARTMENTS

HIGH RISE APARTMENTS

2000 1000 0 2000 FEET





cantly more expensive to service than compact, planned development. Patterns of development are defined by factors such as the number of units per acre, the mix of land uses, and the design and layout of construction. *The Costs of Sprawl* computed the component costs of arranging 10,000 units of suburban housing in six different patterns, of which three representative examples are shown on the previous page.

Each pattern serves the same number of people and has the same amount of commercial space. The study simulated conditions on the developing urban fringe, and the "high density" option is not very high — it includes single-family homes, no building has more than six stories, and the average density is three dwelling units per gross acre.

Average public cost breakdowns of the study are shown above. It is clear that most of the cost difference between community types is taken up in greater street and road costs for low density development, but all costs except the capital cost of land are uniformly higher as development is spread out.

The Costs of Sprawl does not deal with changes in per capita public service costs as communities grow. It addresses only average costs associated with different development patterns in a fixed-population community.

The evidence on how public costs are affected by population growth is conflicting. It seems to depend very much on the particular characteristics of both the community involved and the growth that occurs. For large communities, several studies have indicated that most per capita service costs rise rather than fall as the communities get larger. The graph above, developed from 1970–71 U.S. Census data, shows how per capita costs change with overall community size. There is no clear indication why this trend exists, but it does suggest that, for whatever the reason, as communities become urbanized, their service costs per capita will rise.

For smaller communities, on the other hand, average costs may fall with further development as facilities become used to capacity. One police car or fire station may be able to handle more

(left) Source: RERC

(above) Source: Adapted from material in *Fiscal Impacts of Land Development* by Thomas Muller, published by the Urban Institute.

Large amounts of growth occurred in Lexington, Massachusetts, in the 1950's, when Route 128 was made into a major circumferential highway. Several schools were built for the children of new residents. Now the population is getting older, new construction has slowed as the town becomes full, and the schools are emptying. In 1960, 21 percent of the population was in the child bearing years between 25 and 40; in 1970, this had dropped to 17 percent.

The figure on the following page shows what this has done to elementary school enrollments over the past 20 years. The town is planning to close five of its older schools by 1980, partially because of declining birth rates, but also as a result of changing age structure.

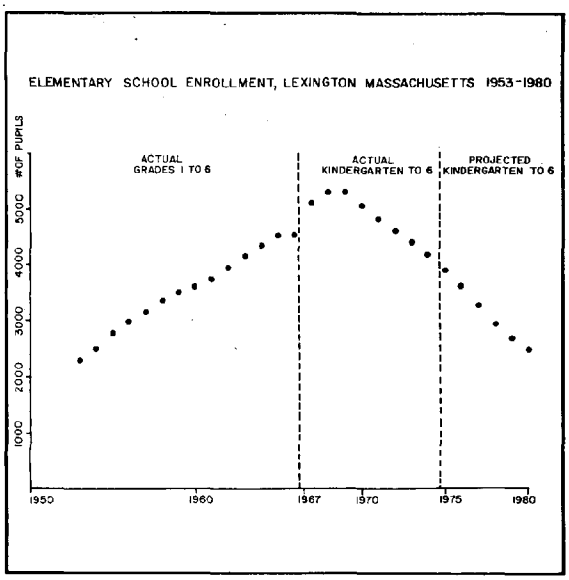
people without reducing service quality, while splitting the costs over the larger population. With extensive growth, however, the additional people are likely to require new schools, fire houses, police stations, and the like, and tax rates are likely to rise. Existing residents may wind up paying more money for the same level of service they received before because they are paying for facilities built to serve future populations.

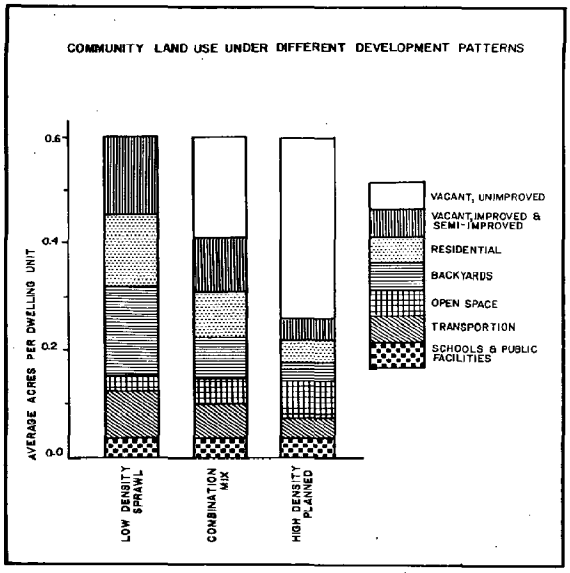
New development may bring in residents of a different socio-economic status than existing residents with resulting benefits and costs. A common example is where a new highway turns a rural community into an affluent suburb of a metropolitan area. In such cases, the new residents may demand additional public services such as libraries, sport facilities (golf courses, tennis courts), recreation centers, parks, and public parking lots. The costs and the benefits must be shared by the existing residents.

For reasons which will be discussed later in this chapter, development induced by infrastructure investments frequently occurs in scattered locations away from already developed areas. This "leapfrog" development pattern carries high public costs, since utility lines, streets, and services must be extended long distances through vacant land. Even if the intervening land is ultimately filled in, the community must bear unnecessarily high service costs in the interim. It also finds itself locked into sprawled out low density development patterns for the long term, with all its implications for higher public service costs.

If development occurs at a rapid rate, as is often the case where infrastructure changes are made in a region with strong economic growth, another group of economic impacts may be felt. In an area where a great deal of single-family housing is built over a short time, most of the residents moving in will be about the same age, as will their children. It will be necessary to build schools to serve this large group of children, but after they pass through the number of school age children in the community will drop suddenly. A large portion of the school space may then be useless, as is the case in Lexington, Massachusetts.

Because the economic impacts of new development depend so much on the particular characteristics of the situa-





tion, any conclusions about a specific development have to be based upon specific analyses. The bibliography to this chapter lists some documents which will assist the community in making these analyses.

Environmental Impacts of Residential Development

Development usually degrades the environment to some extent, but growth induced by infrastructure may bring with it particularly heavy environmental impacts because it tends to be unanticipated, uncoordinated, and, therefore, haphazardly distributed and poorly designed.

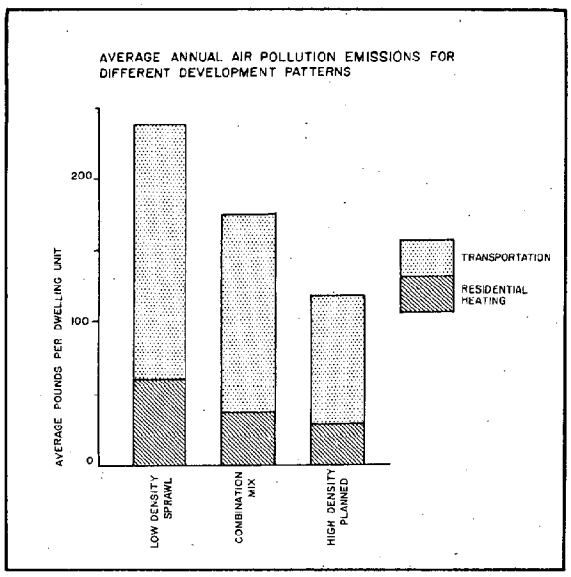
The production of air pollution, water pollution, and solid waste, as well as overall rates of energy consumption, are largely determined by population size. The pattern in which development may occur also affects the amount of pollution a given population will generate, but to a lesser extent. Actual environmental quality is determined by how the pollution is abated before it reaches the environment, and how much of the remainder is absorbed by the environment. The former depends on how carefully the development is designed and constructed, and the latter depends on the natural assimilative capacity of the local environment, as well as the location, pattern, and density of development.

- Land Use: The overall land budget for the alternative community patterns analyzed and discussed in *The Costs of Sprawl* is presented above. There is a striking difference in the amount of land required to house a given population as better planning and increased densities come into play. One major change is the potential drop in the "vacant, improved and semi-improved" category, which shows the amount of leapfrogging and wasted space within the community. Private backyard space and land used for transportation also decline. Planned open spaces are assumed to actually increase as densities rise; these include parks and private communal grounds in cluster and planned unit developments.

As communities opt for more planning and more compact development, a great deal of land can be left vacant and

(left) Source: Lexington Town Reports

(above) Source: RERC



unimproved within the town boundaries. This land is available for future population expansion or for open space. It may be used to protect sensitive ecologies, such as streams, forests, or wildlife areas, and it can have a high recreational value to the community. Conventional "sprawl" communities have virtually no unimproved vacant land. In the "planned-mix" community, however, vacant unimproved land is 33% of the total — in the high density community it jumps to 56%.

• Air Pollution: The major sources of air pollution in non-industrial areas are transportation (especially automobiles) and the space heating of buildings. The graph above shows the estimated amount of air pollution produced *per dwelling unit* for the three basic community types discussed previously. These estimates are based on the average number of miles driven locally per household in the different development patterns, and on the amount of natural gas needed to heat the various dwelling types.

Converting these data into estimates of actual community air quality is difficult. Air pollution diffuses over large areas and most of the air pollution in a suburb is generated outside the community's boundaries. However, to the extent that the community is affected by locally generated air pollution, higher density developments, while producing less air pollution per dwelling unit, may have worse local concentrations of air pollution because they have more dwelling units per acre. In general, however, within the moderate overall densities represented by these prototypical communities, lower air pollution emission rates are likely to lead to better local and regional air quality. More highly planned communities — with their lower emission rates and greater amounts of open space for absorbing pollution — will have better air quality than unplanned, sprawl communities, no matter what the density.

• Water Pollution: Communities must contend with three major forms of water pollution — sanitary sewage, surface runoff (which includes stormwater flow and sedimentation) and groundwater pollution.

Sanitary sewage production is directly related to community population size. Many small communities, however, can manage their sanitary sewage problems with on-site disposal in septic tanks. As growth progresses and densities increase, septic tanks usually cause problems: houses are built on lots too small to allow sufficient percolation of wastes into the soil. Sewers and treatment plants must then be installed. But treatment only removes a part of the pollution, and the plant effluent can still cause significant water pollution in the receiving stream. As population grows and treatment plant effluent increases, stream water quality deteriorates more.

The pattern and distribution of land use have virtually no effect on the generation of sanitary sewerage in each

(left) Source: RERC

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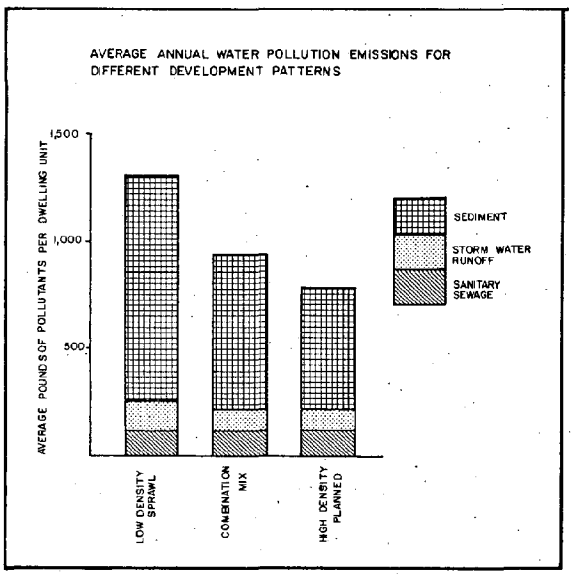
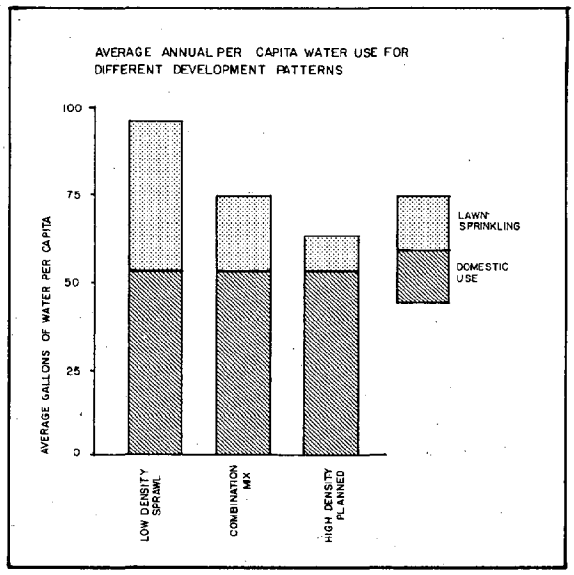




household, but they do affect stormwater runoff and sedimentation. Stormwater flow is water which runs across impervious surfaces or saturated land during intense rains. It can cause serious flooding problems downstream of new development and may also contain significant amounts of pollution. Sedimentation is a measure of the erosion of soil that occurs throughout a community and that reaches local streams. Excessive erosion causes loss of valuable fertile soils and obstructs streams and lakes.

The graph above shows how different community patterns are estimated to affect water pollution. As expected, the communities do not differ in sanitary sewage production, but denser, planned communities tend to generate less runoff per dwelling unit. Again, this depends very much on the care that is taken in the design and construction of the development.

Groundwater pollution occurs when contaminants, such as sanitary landfills or improperly operating septic tanks, reach the water table. Where the water table is high (within a few feet of the surface) or where the soil is very porous, bacteria, viruses, dangerous organic compounds, and heavy metals can often be found in the groundwater in and around developed areas. Once contaminated, the groundwater often takes many years to clean itself, requiring the users of wells to install water treatment facilities or seek alternative water sources.

- Water Consumption: Many areas in the United States face current or potential shortages of water. In some places, particularly in the southwest, water itself is scarce, but the most common problem nationally is lack of adequate treatment facilities. Increased environmental pollution has recently forced a reevaluation of how much treatment is required to provide safe water — the Environmental Protection Agency has tentatively identified a need for $1.2 billion worth of new water filtration plants nationwide. This money must be raised at the local level, and rapidly growing communities may find it difficult to keep up with the water demands

(left) The general findings of *The Costs of Sprawl* reported sanitary sewage effluents assuming tertiary treatment. The graph above has been adjusted to represent the more common practice of secondary treatment. Source: RERC.

(above) Source: RERC

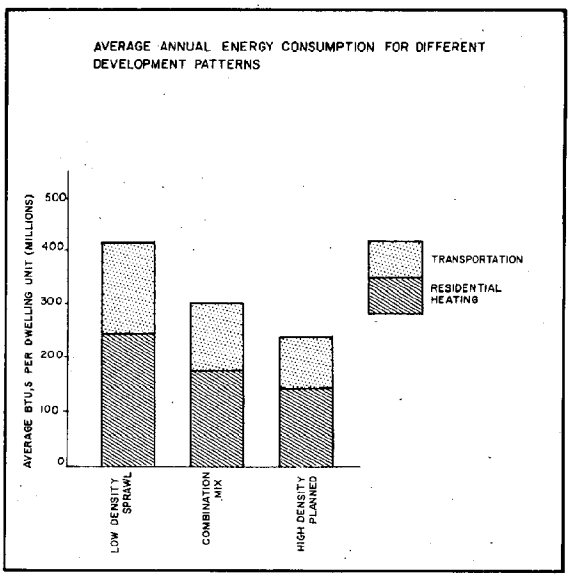
of new development.

Increased development increases the consumption of water. Some of this — typically 50 to 80 gallons per person per day — is used for laundry, dishwashing, toilets, baths, cooking, and so forth. This consumption is basically independent of development patterns or density, except as these affect population. The rest of the water consumed in residences is used for such purposes as lawn watering, and this is strongly affected by the development pattern and by climate. Estimated average water consumption for different community types is shown at left.

A second way in which development exacerbates water shortages is that the construction of impermeable surfaces reduces the amount of rainfall that permeates back into groundwater reservoirs. Higher density development results in less impermeable surface per dwelling unit than lower density developments. In either type, the amount of groundwater recharge can be significantly increased by sensitive design and siting, and by the construction of holding ponds and recharge facilities within developed areas.

• Solid Waste: Population growth induced by infrastructure investments will increase solid waste disposal problems in a local area. Although the production of solid waste may vary a small amount according to the living patterns and income of the population, virtually nothing can be done through land use controls to reduce the amount of solid waste a given population will produce.

As population grows, finding a suitable site for disposal becomes more difficult. Satisfactory landfill sites are also good building sites — they have low water tables, and good transportation access (for garbage trucks). As development progresses, prices for landfill sites rise, making them more difficult to obtain. Furthermore, residential neighborhoods try to exclude odorous and unsightly landfills from being located nearby, and even well-designed landfills are generally perceived as "dumps" by nearby residents. For these reasons communities may be forced to acquire less than satisfactory alternative sites, or dispose of their wastes in a more expensive manner.



• Energy: Energy conservation is now a national policy. While high per capita energy use remains the norm throughout the country, some patterns of development are significantly more energy efficient than others. The unplanned sprawl pattern characteristically induced around suburban highways and in new sewer service areas has a particularly low energy efficiency under current technology.

The graph above compares the three development patterns as they affect energy use. Most of the energy savings attributed to clustered patterns of higher density development result from savings in transportation fuel. High density communities, being compact, reduce the average mileage of local trips, and there-

(above) Source: RERC

by save gas. Also, other modes of transportation can replace cars for some purposes — mass transit for work trips, walking for light shopping trips. Savings in heating fuel are obtained in high density patterns because of shared walls between units (townhouses or apartments), and because larger, more efficient furnances may be installed to serve more than one unit.

The Social Impacts of Residential Developments

The land use changes induced by new infrastructure projects may carry with them important social impacts, but they are intricately linked to conditions in individual communities. A few general comments can be made, however, based on the fact that the social impacts of development depend both on the people who are attracted to a growing community, and where and how they settle within it.

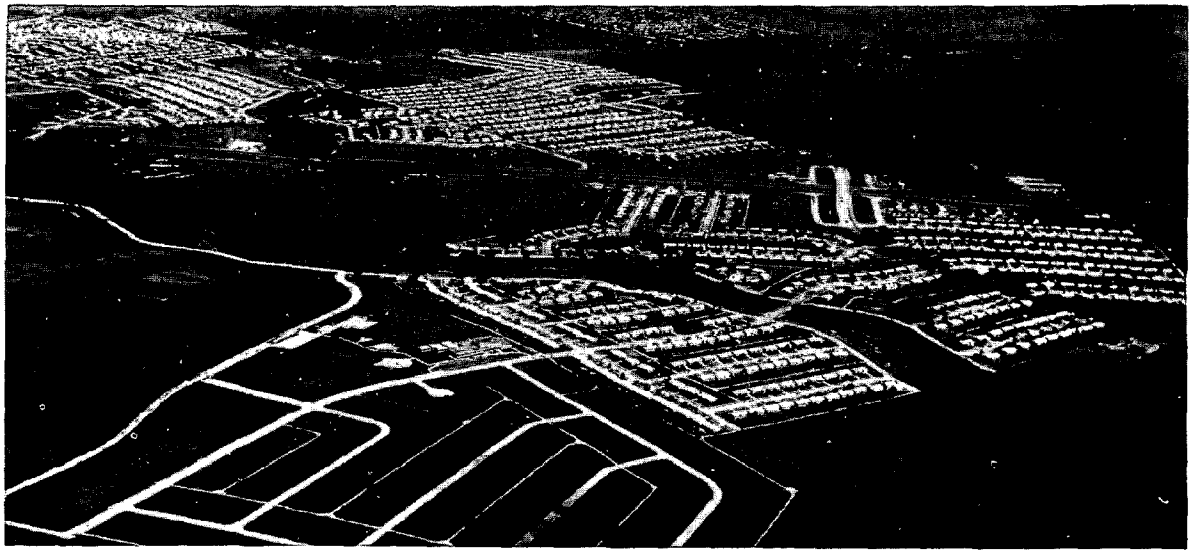
In rural communities on the fringe of metropolitan areas, the first wave of population increase is usually the most significant socially. If new population is brought into a predominantly agricultural region by a highway, this implies a trend away from farming and toward purely residential land uses. The new population will tend to work outside of the community at occupations different from those of present residents; they will probably have a different income status, a different political outlook, and perhaps different ethnic backgrounds. Over a few years, this leads to a realignment of the community's political and economic system, and the original social structure is exchanged for a new one.

In urbanized areas where significant increases in development density might follow the installation of a rapid transit system, neighborhood social effects can be strong. Some transit-induced land use changes are socially advantageous to existing residents, others are not. For instance, a declining neighborhood might experience a rise in local property values, and the construction of commercial facilities offering more local jobs. On the other hand, local land values might rise high enough to price original residents out of the area; this is especially likely to happen in areas with rental housing, since renters cannot cash in on rising land prices.

The pattern in which growth occurs also carries with it social implications. Studies typically show that about three-quarters of the population prefers ownership of a single-family house to all other options. Among young married people with children, the rate climbs to 95 percent. This widespread preference is backed up by hard dollars, for people clearly are prepared to pay a substantial premium for low density living. They pay it in taxes, in travel time to work, and in buying and maintaining expensive homes.

On the other hand, increased housing costs are placing single-family homes beyond the economic reach of much of the population; future communities may of necessity provide a greater variety of housing units and achieve greater economic heterogeneity. There are other social benefits to be gained by planning suburban communities for higher densities. Even with detached single family housing, benefits are gained if otherwise wasted open space in conventional subdivisions is organized into neighborhood parks and recreational space by some clustering of houses.

While designing suburban areas exclusively for higher density apartments would obviously fail to satisfy consumer preferences, many improvements over conventional sprawl patterns may be made without consumer objection or with positive consumer approval. Leap-



frog development clearly represents no consumer preference — avoiding it saves travel time and preserves peripheral open space, both social gains. High density areas in a community will attract single people and young couples, who are often relatively affluent and demand relatively fewer community services. This can help preserve open space and maintain the overall low densities many communities prefer. It may even lead to lower taxes.

Commercial and Industrial Development

The impact analysis above was concerned only with residential developments. But communities should also consider the possible impacts associated with commercial and industrial development that may also follow infrastructure investments. It is much harder to generalize about such development, but the following observations are usually valid.

The taxes paid by commercial and industrial developments usually exceed the costs of servicing them by a large margin.

Because new facilities now have to conform to "new source performance standards" for both air and water pollution, they are likely to degrade the environment much less than older facilities. Much of the industry locating in suburban areas emit little pollution in any case. On the other hand, commercial and industrial developments generate a significant amount of traffic, causing congestion and air pollution problems. New facilities also typically include large areas of impermeable surface in the form of buildings, parking lots, and roads; these surfaces inhibit groundwater recharge, and their stormwater runoff increases local flood hazards and water pollution.

All these problems, as well as other potential environmental and natural resource problems, can be significantly reduced through proper design, and through the government and the individual enterprises working closely together during the design and construction phases, as well as after the facility is in operation.

(above) A housing development east of Dallas, Texas, August 1960. Source: U.S. Department of Agriculture.

Infrastructure Investments and Land Use Changes

Infrastructure influences local land use by changing the supply of developable land, the demand for development, or both. These changes are often highly significant for local communities, for they can bring with them significant economic, environmental, and social impacts, as outlined in the previous section. We now turn to discuss the general mechanisms by which infrastructure investments tend to induce development.

It is easiest to look at land use changes from the point of view of developers. They are the chief actors in the urbanization process, and deal with the market forces of supply and demand in the most direct and practical way. Developers acquire land, remove or modify any existing structures, build their projects, and then seek tenants or buyers. They are, of course, interested primarily in profits, which means that they will undertake developments only when they can reasonably expect enough demand for their development to justify their many costs.

Infrastructure investments can lead to local increases in demand for development or reductions in development costs, and thus create a strong incentive for developers to locate their projects nearby. The presence of infrastructure can both reduce risk and increase profits for developers. While this is obvious, it is seldom adequately considered by infrastructure planners.

The Land Supply

A developer's first problem is finding a site and choosing a type of development to put on it. The supply of land suitable for different purposes constantly fluctuates, and physical infrastructure plays a role along with legal, physical, social, and economic forces.

Some land may be permanently removed from the market by law. Examples are land restricted by conservation easements, protected environmental zones such as wetlands and floodplains, parks (national, state, and local), forests (national and state), and wildlife refuges. Conservation easements can be identified through local and state conservation commissions; other areas to be protected from development (e.g. to preserve valuable agricultural lands, coastal wetlands, or to prevent water pollution) are the concern of state and substate environmental protection and land use agencies.

Other protected land uses are easily located on various maps obtainable from regional planning agencies, technical and engineering divisions of state land grant colleges, or zoning commissions (U.S. Geological Survey maps are useful, but few are completely up to date).

Good land use maps will also reveal parcels in permanent use as power-line, pipe-line and rail rights-of-way, and land held by schools, colleges, military bases, airports and other institutions for expansion and other purposes.

Some legal restrictions on land use, notably zoning, may not be permanent but can hold land out of development in the short term. For instance, land may be zoned for agriculture explicitly to reserve it for future development needs. Other land, while legally developable for the desired project, may not be available at any reasonable price — land zoned for commercial use, for example, is likely to be far too expensive for use for single-family housing because the landowners have higher expectations of its worth.

Physical limitations on development, such as unstable soils, steep slopes, rock outcroppings, and high water tables may be harder to identify. The U.S. Soil Conservation Service and

One cause of leapfrogging is that there are a number of tax and other financial incentives for sale of farmland at the retirement or death of the owner. There is less incentive to sell at other times. On retirement, income drops, the tax bracket changes, and, therefore, taxes on selling the farm will be lower — especially if the payments are spread out over several years. After the owner's death no capital gains tax is paid on appreciation during the owner's life, making it attractive for heirs to sell, especially if they do not wish to farm. Estate taxes may also force the heirs to sell off at least a part of the property.

One survey looked at the reasons for holdouts within developed areas — a prime cause for leapfrogging. Their reasons for not selling are significant:

Waiting for retirement/ inheritance	**— 77%**
Waiting for a better price	**— 18%**
No offers	**— 5%**

Similar results were found for other sales where early leapfrog development occurred; there 68 percent of the sales came through retirement or death, 21% because of a good offer.

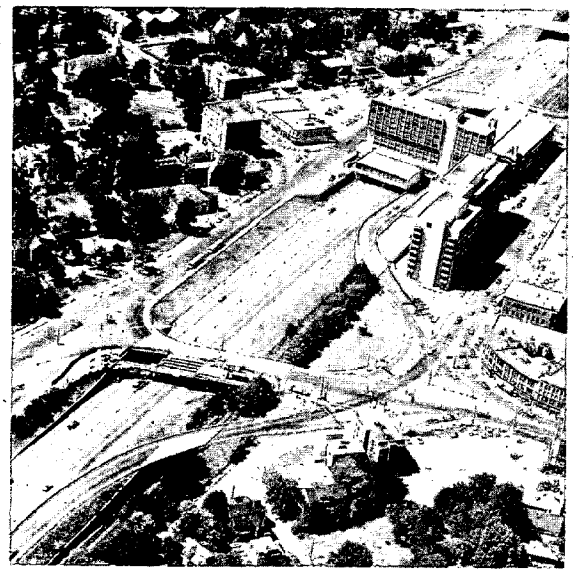
the engineering and technical schools of state land grant colleges may both be sources of useful information. Consulting with major development companies in an area may also be of practical value in determining vacant areas suitable for development. These physical limitations raise development costs, and cause the land to be initially passed over for development until more suitable land is used up and prices rise enough to cover the increased development costs.

Another supply consideration is the willingness of landowners to sell their properties for development. On the urban fringe, much land is held in large parcels by farmers. In many such regions, farmers often sell off their land when they retire because farming profits are declining and they may have no heirs willing to take over the work. Consequently, it is often possible to predict when farm properties will be put up for sale by knowing the age of owners. Price is important, but there are tax advantages to delaying the sale until retirement or the death of the owner.

The land supply may also be constrained simply because of the size of available parcels. Subdivisions, for example, often require hundreds of acres. If parcels must be assembled from many sellers, developers' costs are raised both in time and money. More intense land uses, such as high rise office buildings, need little land and dispersed land ownership will be less of an obstacle to development.

Infrastructure influences the land supply primarily by lowering (sometimes drastically) the costs of development. Sewers are the prime example. Environmental regulations or site conditions often preclude the use of septic tanks. An alternative, the construction by the developer of his own sewer system and small "package" treatment plant, can entail costs which are high enough to make development unprofitable. If the municipality builds the sewer infrastructure, sewage disposal costs are substantially lower, development becomes profitable, and a rapid expansion of housing within the sewer service area may result.

Infrastructure may also remove land from development. For example, highways use land for their rights-of-way. While the amount is insignificant in rural areas, it is significant in cities; this land



can only be developed through expensive construction techniques using the highway air rights. Airports may utilize vast tracts of adjacent land to create noise buffer zones, reducing the supply of developable land. Both of these effects will change the options available to the developer.

Demand for Development

The developer must find tenants or buyers for what he builds. In a rapidly growing metropolitan region, there are large numbers of people and firms seeking locations and large amounts of development are likely to occur. In a stagnant or declining region, there will be little demand for new development. New development responds primarily to regional population and economic growth, although population shifts may also occur within a region over a longer time span.

Developers are concerned with more than regional demand and local development costs, however. They also seek competitive locational advantages — areas within regions that are comparatively more attractive to consumers, and, therefore, more saleable. If a community has good services or a low tax rate, for example, it is likely to be more attractive to developers. Developers building large homes on big lots will tend to build in areas where there already are such homes; developers building shopping centers will locate where large numbers of people will use them, generally near highways and at a distance from other regional shopping centers.

Accessibility is very important. People must travel to work and to shopping; other things being equal, they will prefer housing with the most convenient access to important centers. Businesses will locate where they can easily get employees, and where they have access to their supplies and markets.

Infrastructure affects demand for development by changing the attractiveness of a specific area for a particular kind of development, or by changing its access. Public recreation facilities, which can be considered a kind of infrastructure, increase local amenities and tend to attract population, often in second home developments. Rural highway interchanges attract travel services such as gas stations and motels.

In metropolitan regions, the most important way in which infrastructure affects demand is by changing access to shopping or jobs. Suburbanization has been greatly reinforced by the construction of highways; new roads serving distant areas may lead to the conversion of undeveloped land to housing. Similarly, mass transit lines may promote residential development at outlying stations for people who do not use cars.

Research has failed to discover a simple way in which to estimate local demand for new development. In the case of housing, however, one quick and reliable indicator of *lack* of demand does

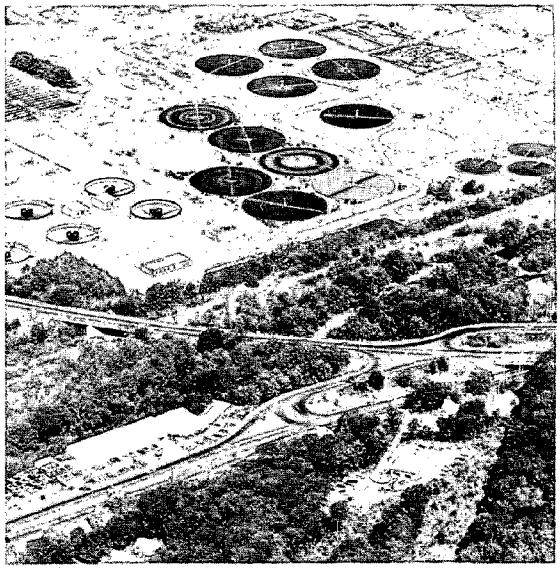
(left) Gateway Center, a multi-purpose development using the air rights over the Massachusetts Turnpike at Newton, Massachusetts.

exist — the local housing vacancy rate. If it is above about 5%, then it is highly unlikely that extensive development of vacant land will occur, assuming no change in local attractiveness or transportation access. But there is a minimum vacancy rate of several percent regardless of other conditions, both because people are always moving and because old housing stock deteriorates. This minimum rate varies from place to place. Actual housing vacancy rates are listed in U.S. Census reports, and may be updated more frequently by state or local censuses.

The most effective way to estimate present demand for housing development is to consult with real estate agents, developers, and assessors. Real estate agents especially can give an objective account of housing prospects in an area, taking into account the amenities, or lack thereof, which affect an area's competitive position for attracting growth. Developers, while perhaps less willing to reveal their full knowledge, are also aware of market trends. Assessors can provide basic information on the trends of housing values — areas where housing prices are growing particularly fast are likely to attract further growth if the supply of developable land is expanded.

Research into recent land transactions in an area is another approach to estimating demand. Speculation in land is a fairly reliable indicator of potential development. The creation of developable parcels, either through the assembly of contiguous small plots or the division of unusually large ones, may be the first overt sign that development is likely. Registries of deeds maintain current records of such transactions.

Development potential over the long term should also be estimated. While little current interest in development might be found, over the long term regional growth may increase development

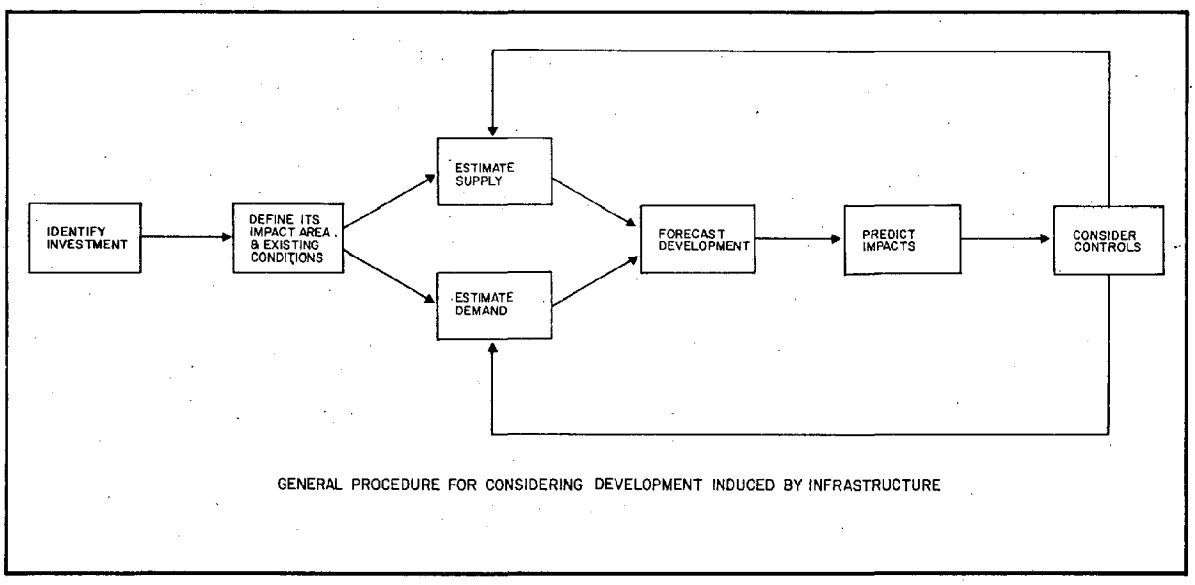


pressure. If regional forecasts indicate strong growth trends, it is more likely that substantial development in the project service area will occur, depending on its relative attractiveness in terms of access to employment centers, and other amenities.

Interactions between several infrastructure investments may affect development demand over the long term. Interactions are significant both between infrastructure of different types and between multiple projects of the same type. Both highways and sewers are often necessary before development in an area can proceed actively. While both are not *required* for development, they may serve jointly to change substantially the relative attractiveness of an area, and thus determine the rate, pattern, and density at which development occurs.

Interactions between mass transit and sewers may be similar to those of highways and sewers, but there are too few recent transit projects to draw conclusions. Interactions between highways and mass transit facilities are equally

(above) A new sewage treatment plant to serve suburban development, under construction near a suburban highway interchange.



GENERAL PROCEDURE FOR CONSIDERING DEVELOPMENT INDUCED BY INFRASTRUCTURE

hard to predict, though it would be safe to say that they would tend to increase development density.

The interactive effects of multiple infrastructure projects should be studied carefully. Normally, one is reviewing only one project at a time, yet it is clear that the basic changes in urban form wrought by infrastructure, especially highways, has been due to extensive systems built over a period of years, not by isolated projects. It is also true that a particular type of investment has quite different impacts depending on when it is built. The first highway in an area may have substantial local effects, but the twentieth one will probably have much less.

This discussion has focused on how infrastructure investments can shift existing or potential demand. Whether or not infrastructure can *create* new demand for development is another more controversial point. It is certainly possible that the Federal Highway Program, for example, has so improved transportation in and between cities that it has actually created economic growth. A more conservative view is that infrastructure seldom creates growth, but merely concentrates part of the region's development into its own service area. This is especially true for smaller projects of the sort considered here, such as single highways or sewers.

Estimating What Development Will Occur

The past sections have shown some of the impacts of land development, and explained how infrastructure investments can affect that development. For planning purposes, though, it is necessary to have a procedure for estimating what development will occur, and what impacts it will have. This section outlines a simple and rough procedure for this purpose which is developed further in the subsequent chapters.

Each type of investment has its own characteristics, and each one must be handled differently. However, the basic goals of the procedure and the general steps involved remain the same. Virtually all development related to infrastructure is localized in a zone physically adjacent to the investment and served by it. The first step is to define this *impact area* and to look at how it has been growing in the past.

The second step is to look at the *supply of land* in the area, and to assess what land is available, what services are offered, whether there are physical or legal development restrictions, and whether land is likely to be sold at a reasonable price to developers. Investments such as sewers might change the availability or price of land for different uses. In some situations, redevelopment of existing uses may also be possible.

The third step is to consider *demand for development.* Residential demand will generally depend on how fast the region is growing, on how attractive the impact area is, and on what sort of access it has to jobs, shopping, and other amenities. Commercial demand will depend on whether there are people who would travel there to shop or work.

Demand and supply must then be combined to give estimates of what development will occur. Three questions are of interest here:

1. How much development will occur, and where will it go?
2. What development patterns and densities can be expected?
3. At what rate will the development occur?

The answers to these three questions will characterize the development and give an understanding of the likely consequences of the investment.

The fifth step is concerned with impacts. Once some idea of the likely amount, pattern, and rate of development is found, approximate resulting impacts can be predicted. The discussion earlier in this chapter is relevant, and there are other publications (some of which are listed under *Further Sources* at the end of each chapter) available on predicting impacts which would be of use to the local planner.

The final step is to consider how the impacts attributable to infrastructure investments may be controlled. This handbook emphasizes the importance of modifying infrastructure design to control development and its adverse impacts. Specifying design changes for various investments will be discussed in succeeding chapters. But it is also important to consider other land use controls.

Controlling the Impacts of Induced Development

There are two possible ways of dealing with the potential impacts of induced development. One is to control the development, and thus limit the impacts. The other is to respond to the impacts after the fact, by providing various services or facilities (e.g., police protection or sewage treatment plants). Both approaches are effective and sound, but the emphasis here is on limiting impacts by controlling development. Most communities have experience responding to development impacts; few are adept at preventing them.

Prevention can be accomplished through land use controls. However, in the case of development induced by infrastructure investments, changing the design of the infrastructure itself is often the simplest and cheapest way of controlling land use changes.

Infrastructure Design Changes

Changing the design of the proposed infrastructure investment can change its effect on the local supply of developable land or the local demand for development. A reduction in capacity will reduce the amount of development which the infrastructure can support: there will be less development induced by a two-lane road than an interstate highway, all else being equal.

Changing the route of the infrastructure can also be effective in controlling

In 1969, the town of Ramapo, New York, which controls 60 square miles of bedroom suburbs serving New York City, enacted a revolutionary ordinance which tied future residential development to an 18 year capital facilities program. To obtain approval for a development, builders must demonstrate that adequate public facilities exist to serve their project, or build the facilities themselves at their own cost. Growth is still allowed in Ramapo, but it is being guided to fit the needs of the community and minimize public costs.

Since its passage, many social defects of the ordinance have become obvious. However, a valuable precedent has been made. Growth in Ramapo must follow, rather than precede, the ability of the town to service it.

Such ordinances, if tied to a program to provide housing for all income groups (which Ramapo planned but has conspicuously failed to do), could do much to control haphazard sprawl created by unplanned infrastructure investment.

induced development. Sewer lines may be aligned to avoid large completely vacant tracts, and to encourage the completion of development in partially urbanized areas. Highway interchanges or mass transit stations can similarly be located to stimulate infilling and avoid further sprawl.

Staging the investments can also have an impact. A highway or a sewer can be extended in phases. Several small projects, again built in phases, can substitute for one large scale project. Since it is more difficult to control rapid growth than moderate growth, staging can be an important technique.

The local community can often influence such design considerations, and thus control growth. Careful planning of interchanges and frontage roads, parking facilities, access provisions for parks or airports, and the like are very important in guiding new development, and in reducing its adverse impacts.

It is also possible to guide growth in a community through the provision of public facilities. If a community develops a capital investment plan for extending necessary services like sewers, schools, and water supply, it may be able to require developers either to pay the cost of service extensions or to locate where services are available. This method reduces community costs, cuts down on leapfrogging, and controls the rate of development.

Zoning

Zoning is the most familiar and widely used land use control and is the most powerful planning tool available to local government. Zoning designates permissable uses and restrictions on various defined districts within a larger area. It receives its power from the police power provisions of the Constitution, and is defined by state enabling legislation.

Unfortunately, conventional zoning has often been unable to cope with the great pressure for development in many suburban areas. And where rapid new development is being induced by an infrastructure investment, there is often irresistable pressure for zoning changes which may be harmful to the community.

Innovative zoning methods such as cluster zoning, density zoning, and planned unit developments (PUDs) have

Zoning can act against its own goals if variances are easy to get. Land zoned for apartments is ordinarily much more valuable than other residentially zoned land, so in the early 60's owners in Montgomery County, Maryland, raised their asking prices accordingly. Developers, however, found variances easy to get, and simply bought land in single family districts and had it rezoned. One writer says, "It almost appeared that the best way to keep apartments out of the area was for the Planning Commission to take the initiative in rezoning it for apartments."

Development along streams can lead to polluted water supplies and flooding. Many communities have zoned buffers around streams, allowing no development within 50 feet or so to reduce impacts. Napa County, California, uses such a buffer. In other areas, such as Placer County, California, the boundary size depends on the conditions of soils, the land slope, and other factors; this reduces impacts, but is harder to administer. Zoning of sensitive areas to reduce impacts is an important land use and environmental control tool.

gained acceptance in many communities across the country. All allow increased concentration of uses in some parts of a site in exchange for more open space in other parts. Such techniques can reduce municipal capital and service costs, reduce environmental problems such as stormwater runoff, and protect sensitive areas. A wide amount of literature is available on all of them.

Special zoning for sensitive environmental areas can reduce the environmental impacts of development considerably. Streams and creeks, wetlands, woodlands, hillsides, and groundwater and aquifer recharge areas are prime candidates for designation as sensitive areas; development on them should be controlled or, where necessary, prevented. In some cases, such controls are not necessary until land costs become high — hillsides, for example, are expensive to build on and tend to be developed last. Other sensitive areas are inexpensive to develop but have high value to the community as open space; for instance, floodplains are often prime development sites, yet they should be protected from development to avert costly flood damage and protect water quality and the local ecology. For such areas, early regulation is important.

Purchase of Land Rights

Zoning is legally strongest when it is designed to prevent an obvious public harm, as when industrial uses are excluded from residential zones so that property values are secure and public safety protected. Where the purpose of zoning is to provide a public benefit, as when land is zoned for open space, owners of restricted land may sue for compensation — they may have been deprived of future benefits from development. In such cases conventional zoning may fail, and public purchase of property or development rights may be required to limit development or protect sensitive environments.

Conservation restrictions are often used to protect open space or sensitive areas. A community, in effect, pays an owner not to develop all or part of his land. It buys the "development right" either in perpetuity or for a set period of time such as 30 years. Alternatively, the public can buy the land outright and "bank" it. Landbanking is expensive,

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but cheaper options than immediate outright purchase are available. These usually give the present owner continued use of the land in its undeveloped state. References on the topic may be found at the end of this chapter.

Controls on Subdivisions and Construction

Subdivision regulations may control storm drainage, pavement type, curbs, sidewalks, street grades and widths, utility burial, amounts of recreational land, and other aspects of new development. They can, therefore, be used to set performance standards for environmental management — standards for holding stormwater and timing its release to sewers, for example. Adequate standards for septic tank design and maintenance may, if local soils are suitable, solve wastewater management problems without provision of sewers. With performance standards, the developer can use either land use designs or engineering solutions to meet the community's goals and standards.

Building codes also can be used to ameliorate adverse development impacts. Requiring high standards of insulation in new houses will reduce energy consumption and air pollution from space heating. Construction and design techniques can help control noise problems in both public and private buildings. Plumbing codes may be designed to cut down on water use and reduce sewer loads.

Further Sources

The literature on the dynamics of land use change is large and rapidly expanding. A good general introduction is Marion Clawson's *Suburban Land Conversion in the United States* (1971); it reviews the process of urban expansion in a readable and enjoyable way.

Another introductory reference on urban growth, one with a strong emphasis on environmental problems, is *The Use of Land: A Citizen's Policy Guide to Urban Growth* (Reilly, 1973).

(left) This suburban subdivision is encroaching on forested land, increasing potential sedimentation and erosion problems for local streams, and diminishing local aquifer recharge.

(above) This earthslide in San Anselmo, California, demolished newly constructed apartments following heavy rainfall in January 1967. Source: U.S. Department of Agriculture.

A great deal of development occurred in the 1950's on hillsides around Los Angeles. Each year the rainy season caused erosion and land slides. By 1963 the city and county had developed regulations on the density and engineering of hillside sites.

In 1969, the county received the heaviest winter rainfall in over 85 years. The average hillside site under the new regulations received an average of only $16 damage; sites developed before 1963 received ten times as much damage, and many houses were totally destroyed.

The Environmental Protection Agency has published *Land Use and the Environment, An Anthology of Readings* (by the American Society of Planning Officials). The contents summarize the new land use ethic and cover the range from local control applications to national policy goals.

Literature on quantifying the land use impacts of development is still discouragingly small. *The Costs of Sprawl,* which covers economic, environmental, and social impacts and is the source from which most of the chapter's land use impact information was taken, was published in three volumes: an *Executive Summary,* a *Detailed Cost Analysis,* and an extensive *Literature Review and Bibliography.* This study based its analysis on theoretical average cost and pollution figures for different development patterns, and its conclusions should be read with that in mind. Other useful studies concentrating on fiscal impacts include the State of New Jersey report on *Housing and Suburbs: Fiscal and Social Impacts of Multifamily Development* and two reports by the Urban Institute: *Fiscal Impacts of Land Development* by Muller, and *Measuring the Impacts of Land Development* by Schaenman and Muller. Further work on such subjects is underway and several valuable studies should be completed during the coming year.

Another recent study, published by the U.S. Department of Housing and Urban Development, is the *Interim Guide for Environmental Assessment, HUD Field Office Edition.* This is a handbook for identifying and evaluating the environmental impacts of proposed development projects; it describes practical field tests appropriate for identifying potential environmental problem areas, as well as advanced tests and technical references for quantifying and evaluating them.

A valuable new compendium of articles on growth and its control has recently been published in three volumes by The Urban Land Institute, called *Management and Control of Growth* (Scott, 1975). The hundreds of articles presented give a comprehensive view of current thinking on growth control, its political, legal, and environmental implications.

Another recent source is *Future Land Use: Energy, Environmental and Legal Constraints* (Burchell and Listokin, 1975). This collection of articles supplements the readings in the Urban Land Institute's anthology.

Ian McHarg's *Design with Nature* presents a landscape planner's approach to translating environmental theory into practice. The book presents a way to analyze all land as to its suitability for various types of development.

Extensive bibliographies on hundreds of planning topics are available through the Council of Planning Librarians; major libraries often carry them, or one can write the Council for their current catalog.

Those interested in finding detailed land use information specific to their own locale may contact the planning and law schools of nearby universities, local conservation commissions, and regional planning agencies.

2 Highways

Old Route 23 snakes northeastward out of Atlanta through a broad valley of Kudza and Yellow Pines. At one time people and freight passed through Suwanee, Flowery Branch, Buford, and Gainesville on the slow journey to the other manufacturing towns of the Piedmont, Washington, and the major northeastern cities.

This all changed when Interstate 85 was completed and a modern limited access connection was established between Atlanta and Richmond, Virginia (to the Northeast), and Montgomery, Alabama (to the Southwest). The improved North and South Highways diverted long haul coastal traffic through Atlanta. At the same time the truck traffic helped fuel the rapid economic expansion experienced by Atlanta in the last decade. And, until the expressways were constructed, poor access to the open land ringing Atlanta confined new housing to the city limits and parts of nearby Dekalb County. The interstate system permitted Atlanta to expand to a seven county metropolitan area encompassing over 2000 square miles.

Development around the North Druid Hills Road interchange, about 15 miles from the heart of downtown Atlanta, exemplifies these patterns of growth. When this stretch of I-85 was completed in the mid-fifties, pine forests covered most of the area around the interchange. Now, eight gas stations, an office park housing the regional operations of many major corporations, a shopping center and many fast food chains and other service businesses are within a few minutes of the interchange. At least fifteen light industrial operations have located on the frontage road. Within 10 minutes of the interchange, thousands of apartment units have sprung up along North Druid Hills Road, Buford Highway, and small feeder roads constructed by developers.

In the past twenty years, highways have played a major role in shaping American cities. New highways have been characterized both as the destroyer of inner cities, and as a necessity in their revitalization. Radial superhighways built to aid access into central cities have led to an exodus from the city to the suburbs. Circumferentials, often built to let traffic by-pass cities, have themselves become congested because of businesses and households which locate along them. Major shopping centers have located at the interchanges of limited-access highways. Commercial strip development has occurred along the sides of access roads and other highways. In some cases, through traffic on the highway has generated employment by providing demand for goods and services. The Atlanta example shows the large-scale effects highways have had on development. The trend of suburbanization may be changing, but highways still have an impact.

(above) North Druid Hills Road at the Atlanta Northeast Freeway, 1957. Source: Georgia State Department of Highways

(opposite) The same interchange in September 1973, after extensive development. Source: Georgia State Department of Highways

One of the major highway by-pass studies was done in Blairsville, Pennsylvania, about 1960. The main local highway, U.S. 22, was relocated around the congested center of town in 1953. Land use change over the next several years found that most new commercial and light industrial development located on the bypass. Since there was less congestion in town, the area became more attractive for local business, as the table shows. If, though, the economy had concentrated on serving through travelers, the results could have been very different.

	Market Street		By-pass	
	Pre-bypass	Post-bypass	Pre-bypass	Post-bypass
Gas Stations	4	6	0	5
Restaurants	11	13	0	2
Motels	2	5	0	1
All Business	207	216	0	8

The effects of highways on land use and development are addressed in this chapter. These effects result primarily from the change in access to developable land which highways provide. Three common examples of such development are the rural interchange which seems to sprout gas stations, restaurants, and motels overnight, the suburban area which becomes dotted for miles around with subdivisions and shopping centers after the new interstate is built, and the local highway which blossoms with garish strip commercial development.

Rural interchanges of limited access highways often become developed with service facilities catering to through traffic. Businesses which locate there usually have little local market and cannot support themselves without the highway. In this case, the highway provides a net economic gain to the community.

In suburban areas such as around Atlanta, radial highways and beltways have drawn businesses and households from downtown and helped create more widespread housing and employment centers. In general, the bigger and faster the highway the larger these impacts will be, so long as the road gives access to areas where people would like to work or live.

If it is easy to get on and off the highway — if there are unlimited curb cuts and all intersections are at grade level — then development can occur along the sides of the highway in a "strip" of stores, restaurants, motels, gas stations, and apartments. Single-family housing may spread out behind these strips on the many crossing roads.

If the highway is of the interstate type with limited access, then the push for development will be at interchanges, and cross streets may become major arterials with their own strip development or office parks. The highly visible land along the road may be developed through construction of frontage roads.

In some cases, highways have minor effects. In the 1950's, a large number of "by-pass" studies were done to see whether construction of a by-pass around a town hurt local business. In general, the original roads and the by-pass were state or federal highways, two to four lanes wide, with unlimited access, and the towns were centers of rural areas. The by-pass roads had little impact. Only a small portion of the com-

Thirty-six rural interchanges on Interstate 70 were studied in Pennsylvania in 1966. Most interchange development was to serve travelers — gas stations, restaurants, and motels — and residential and other developments were further away. Interchanges on important cross routes got more development.

Of the 17 interchanges more than 14 miles from an urban area, only 6 had any development. Of the 19 within the 14 miles of an urban area, 17 received some development. No development occurred without easy on-off access.

In 1949, Route 128 around Boston was opened and quickly became a classic example of the power of highways to induce local growth. Glamour industries such as computer electronics firms moved in, drawing labor from Boston itself and local suburbs. Later another circumferential — Route 495 — was planned; it was billed as "another 128." While the roads were similar in configuration, economic conditions were different: 128 apparently drew off all the glamour industries; 495 was too far from downtown to yield extensive land use changes.

munity depended on serving through traffic, and even with the by-pass people would stop if they needed to, so the areas were not hurt.

The interstate beltways were also supposed to act as by-passes around metropolitan areas, but they showed very different development patterns. Highways like Route 128 around Boston attracted large amounts of residential and industrial development, and have served as the sites of regional shopping malls and similar facilities. Traffic generated by this induced development has removed most of the gains predicted for by-passing the central cities. In some cities, several beltways have been built at increasing distances from the center city; in this case, development concentrates on the inner ones, and the outer ones may serve as by-passes.

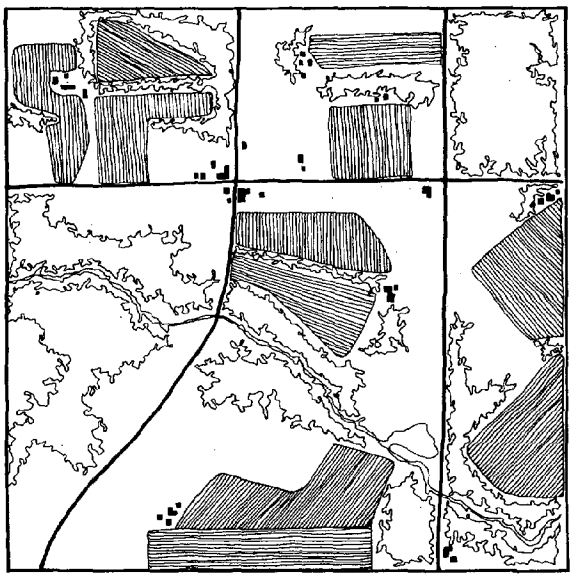
Highways compete with each other as sites for development. The effects of the fourth highway — either beltway or radial highway — will be smaller than the effects of the first. Development will be more spread out if there are more sites with equal access.

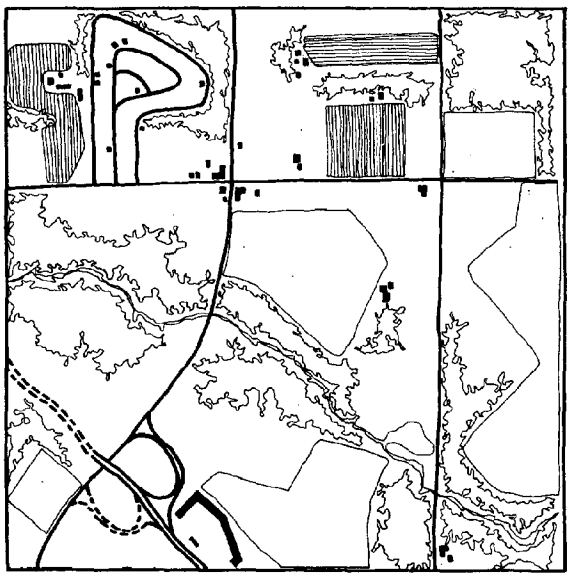
The impacts of highways can be complex. Sometimes, the decision not to build a road has implications as large as that to build one. A number of highways have been planned to go through developed areas, and have later been cancelled. In the meantime, though, banks and mortgage holders have been unwilling to invest in the area because condemnation and demolition are likely. The result has been delayed maintenance, vacant houses which cannot be sold, and spreading blight. After a highway is eventually cancelled, recovery may be impossible.

The following section of this chapter outlines a procedure for analyzing probable land use changes which is based on the framework discussed in Chapter 1. First, the impact area of a highway is defined. Then land availability and the demand for development are identified. It is then possible to estimate the quantity, pattern, and rate of development from the interaction of these two factors, and to go from these to the expected impacts of the land use change.

Defining the Impact Area

The impact area of a highway is the area in which major land use changes



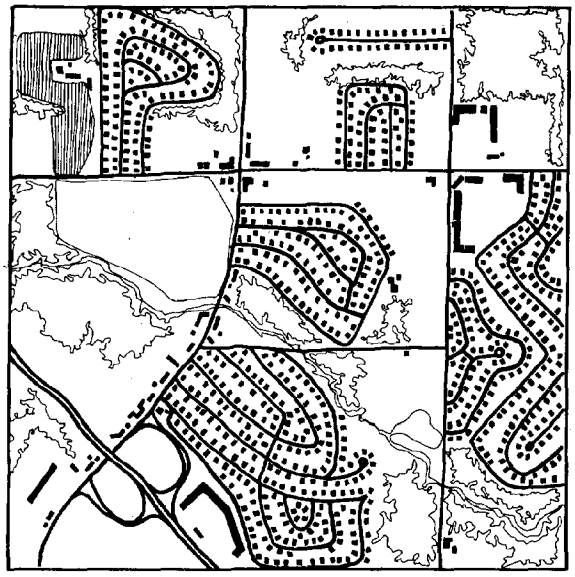


may be expected; its size depends on the type of highway built, its location, and on the other highways nearby. In rural regions it may only be the immediate neighborhood of the interchange where travelers will stop to buy gas, food, or other services. In suburban areas it may extend several miles on each side of the highway. In urbanized areas it must be defined carefully with reference to local conditions.

Rural interchanges are defined as those interchanges on interstate or limited access state highways which are beyond the maximum commuting distance to central city employment. At such interchanges there is potential for development serving through traffic on the highway. This development will vary depending on the traffic flow on the highway and on whether services are readily available at nearby interchanges, but it will concentrate within the immediate area of the interchange — generally within 1500 feet and in areas most visible from the highway. Under special circumstances, particularly in scenic areas or near recreation sites such as reservoirs or ski slopes (see Chapter 5), rural highways may also stimulate leisure home development and some employment. People are often willing to travel long distances to such sites, and development will follow. Some people may also move forty or fifty miles from the city and commute daily to jobs which have moved twenty miles into the suburbs.

A new highway in a suburban area can induce both high density intensive development and low density dispersed development. Intensive development — residential, commercial, and industrial — is more likely to occur near the interchanges. High density residential development depends on how accessible the interchange is to major employment centers and public transit. Commercial development depends on how accessible the interchange is to residential areas and how many people are likely to drive by it. Industrial development will depend on how accessible the interchange is to large labor pools. Because circumferential highways generally provide access to more people and jobs than radial highways, intensive development is likely to be greater at the former than the latter.

For less intensive development, the critical issue is how far people are willing



These three figures show stages in development induced by a highway investment. The first shows rural land, primarily used for farming.

In the second stage, the highway has been planned and construction is underway. One parcel is being developed, but several more have been bought by speculators. Farming has almost ceased.

In the third picture, commercial strips have formed along the road intersecting the highway, and some apartments have been built in the lower right. Open space has been reduced considerably.

to live from the highway. At the urban fringe where even with the highway it takes a long time to get anywhere, people will want to live close to the entrance. For an inner circumferential, where most jobs are only a few minutes along the highway, it is reasonable to spend some time travelling to it.

For small highways or areas far from employment, ten minutes rush hour travel to the highway may be acceptable to most people, so development will occur within that distance.

In fast-growing regions where the highway makes a real improvement in access, a fifteen or twenty minute ride to the highway may be acceptable to enough people to make development profitable. The impact area would then be all the land closer to an interchange on the new highway than to one on an older highway, and within twenty minutes travel (in rush hour) of the new interchange. Twenty minutes is probably a maximum access time to the new highway in any case, and shorter times may be appropriate in most instances.

Defining the impact area of highways planned for urban areas is more difficult because of the complex ways they affect existing communities. Land requirements alone may become a problem, for such highways usually obliterate many acres of existing development. New urban highways tend to divide neighborhoods, disrupt local traffic patterns, and interact in complex ways with regional as well as local transportation networks.

For these reasons opposition to new highways in urban areas is often intense. As a result, construction may be deferred or even canceled, but adverse impacts may still occur as neighborhoods are allowed to decay along the proposed route.

The Supply of Developable Land

The most extensive effect of highways has generally been to increase the development of vacant land into single-family housing. Commercial, industrial, and apartment developments have often occurred in the immediate area of the highways, but usually not more than a few minutes travel from an interchange.

The first supply concern, then, is to estimate the amount of vacant land which is developable and within the im-

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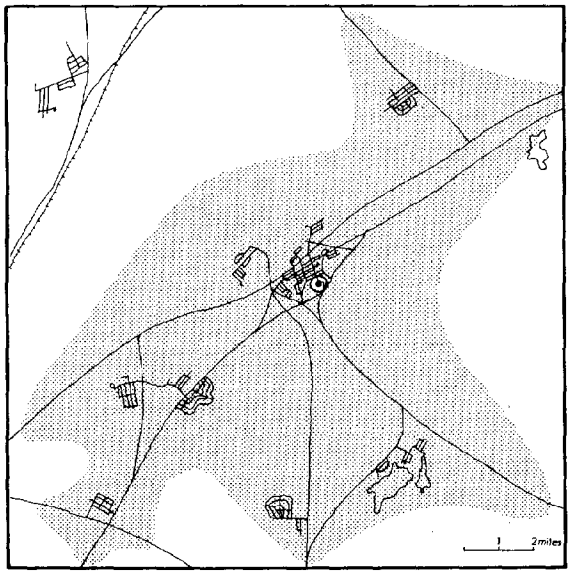
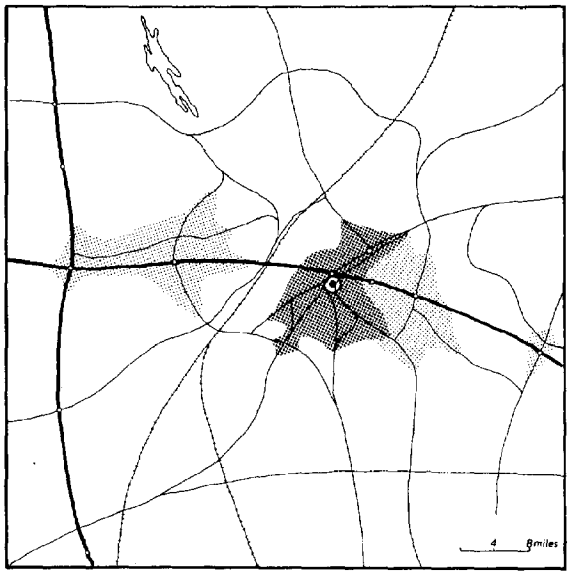




pact area of the highway. Land in low-density use near the highway should also be considered, because it may be converted to denser uses. The importance of the type of land and its cost were described in Chapter 1. Highways in the suburbs tend to induce development on vacant, prime land because it has the lowest construction costs for large-scale developments such as subdivisions and shopping centers.

If the supply of vacant, easily developed land is large, there is little likelihood that developed land will be converted to higher uses, unless its price is extraordinarily low. If there is little vacant land, particularly around interchanges, redevelopment of land and development of marginal areas such as hillsides are more likely. Where very little vacant land exists, development of highway air rights may occur.

Demand for Development

Demand for development is a measure of how many people would be willing to occupy new development in an area, and how much they would be willing to pay. If the demand is high, then the potential exists for fast and major land use changes. If it is low, little change will occur.

Estimating demand for new development induced by a highway in an inner city is complex and beyond the scope of this book. Demand for commercial development around rural interchanges, on the other hand, is fairly easy to anticipate: it depends on the visibility of the interchange and its volume of traffic. Forecasts of traffic volume are available through state highway departments, and may show seasonal variations. For instance, highways serving vacation areas may have a high demand for tourist services during the summer, and almost none during the winter, or vice versa.

For highways serving developing suburban areas, the demand depends on the rate of growth of the metropolitan region, on the relative attractiveness of the area compared to the rest of the region, and on the accessibility of the area. The latter is affected by highways.

Projecting the likely growth of the region and assessing the relative attractiveness of the area will indicate if there is a potential for large, moderate, or

The residential areas from which workers commute to employment are often defined by highways. The left figure on the opposite page shows the area within 30 minutes travel to a center, over local roads. The right hand figure shows (on a reduced scale) the new areas within 30 minutes commuting after construction of a major highway. The dark area is the old commuting area, the light shade shows added commuting area.

The Boston Southwest Expressway was planned to extend Interstate 95 into the city. Construction plans proceeded and the state condemned buildings in the right-of-way. Tenants remained in local areas, but the new landlord — the state of Massachusetts — failed to maintain the buildings. When citizen opposition defeated the entire project in 1970, the I-95 corridor was an urban ruin. Some buildings have been demolished. The social structure of the area was torn apart, and the city was left with a wound which will take years to heal.

small amounts of land use change. The next step is to see if that potential will be translated into actual growth by the change in access provided by a new highway.

If the potential for growth is low, highways will not change it. If large amounts of growth are occurring already, building a highway will make little difference. The important case is where a highway makes an area with high growth potential significantly more accessible to potential tenants and residents.

In general, length of the trip to work is the most important factor in locating households. Simple measures of access are the rush hour travel times to the central business district and other major employment centers in the region. The acceptable travel times will vary from one region to another and among individual households, but the following general rules can be suggested.

ACCESS is GOOD if the rush hour travel time to the central business district is less than about 30 minutes or if there is other substantial employment within 20 minutes travel time or so.

ACCESS is POOR if the central business district is one hour or more distant or if there is little employment within about 30 minutes travel time.

In small regions, these critical times should be reduced somewhat; in the largest cities, such as New York, people are willing to travel further, and the limits should be increased.

Poor access will eliminate most demand for development. People will not locate in an area if there is no work within an acceptable distance, and developers will not build there.

Good access may increase the demand on an area. An area with good access and moderate regional growth and local attractiveness will probably have a relatively high demand for development. Areas of low growth and attractiveness will not experience much of an increase in demand for development even if access is improved.

Forecasting Secondary Effects

The next step is to convert estimates of land supply and development demand into forecasts of the extent of land use change, and the rate and pattern in which it will occur. There are, basically, nine cases to consider: supply and

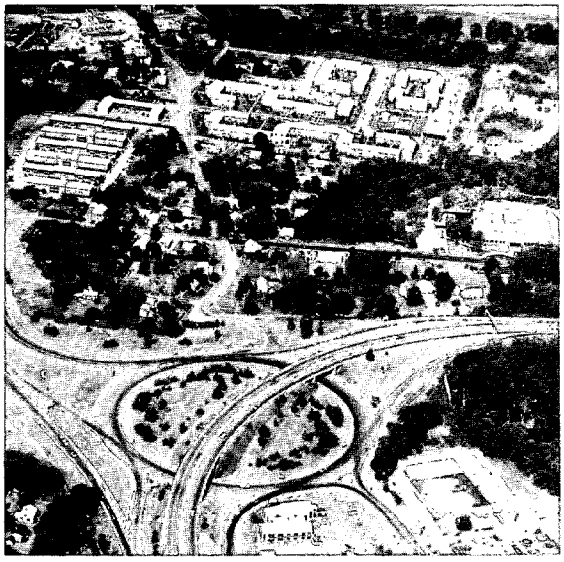
demand can each be high, moderate or low. If demand is low, development will be negligible no matter what the supply of land, so these cases need no further analysis.

However, under the following cases, substantial development may occur:

DEMAND	SUPPLY
High	High
Moderate	High
Moderate	Moderate

These three cases describe traditional development at the urban fringe. The impacts attributable to the highway will depend on the extent to which it is likely to increase demand (by improving accessibility) — from low to moderate or high, or from moderate to high. The typical case is where an area in a growing region is "opened up" for development by a new highway. Development will be primarily residential, with low density subdivisions of single-family homes or of apartments and condominiums. There may be some higher density uses near the interchanges of highways, but usually only if low cost, undeveloped land is available. Almost no conversion of developed land will occur. Leapfrogging is likely, as developers will look for large parcels available at a reasonable price within ten or twenty minutes drive from the highway.

A slightly different development pattern is likely to occur when the demand is high but the supply is only moderate. In this case, the development is constrained. An example would be an area which is partially developed and moderately accessible before the construction of the highway and which becomes highly accessible after construction. Land costs would be relatively high, and most development would probably have to be on quarter-acre or smaller lots to be profitable. A mix between fairly dense single-family houses, townhouses, and walk-up apartments would be likely, with the denser uses closer to the highway. Because of the resulting high population density, commercial and industrial uses might begin to locate in the area. Vacant land would receive most of the development, but there would be conversion of some developed land, particularly near the highway interchanges, to other uses and higher densities.



The highest density development will probably occur when supply is low, but demand is moderate or high. In these cases, land prices will be high, and high density residential, commercial and industrial development will result. Development parcels will generally be assembled from vacant land and older housing, and will usually be fairly small. Infill housing will be constructed, but large subdivisions, industrial parks, and shopping centers are unlikely because of the problems in assembling sites. A typical case would be an older, satellite city given improved access to a central city by a new highway. Another would

(above) New multi-family housing in the suburbs typically locates close to highway interchanges, as here in Springfield, Massachusetts, August 1975.

The access highway from Washington, D.C. to Dulles Airport is unusual. There are no exits on the way to the airport from the city side, and no entrances on the way to the city from the airport. To use the highway to commute to Washington, it is necessary to get on, drive to the airport, then turn around and travel back 25 miles to town. Naturally, it is not very popular — that is how it was planned.

Building a normal freeway to Dulles would have caused major land use effects. Building a special purpose freeway did not.

One way to cut down on strip development along highways is to reduce the number of access points permitted between intersections. This has been done near Columbus, Ohio, where several auto-oriented food shops grouped themselves in a fairly attractive cluster off the main road after the city planning department clamped down on the allowable curb cuts in the area. Traffic congestion is reduced, safety increased and the visual environment is improved by such policies.

be a widening of a major arterial.

In all of these cases, the highway investment affects demand, and, therefore, affects the quantity and pattern of development. It also affects the rate at which development occurs. The change in the rate of development depends upon the overall rate of regional growth, the change in accessibility, and several less important factors such as zoning delays, the time required to assemble parcels, etc.

The Resulting Impacts

Highways are built to improve traffic flow. All else being equal, they should speed traffic, save people time, reduce accidents, and reduce air pollution. However, highways also attract development, and the positive impacts of the highway can be eliminated by the induced development.

Suburban sprawl, the most common induced development, increases both the number of trips people take and the length of those trips. More trips means more traffic, so the development leads to highway congestion, slower travel, more accidents, and more air pollution. The negative impacts of the development may well exceed the positive ones from building the highway.

Two special concerns must be mentioned. First, highways at the fringe of cities tend to induce low-density development, and this development may not be sewered. There is a potential for significant problems with sanitary sewage if wastewater facilities are not provided or if the correct controls are not used.

Second, large industrial parks, apartment complexes, and shopping centers may locate near interchanges. These areas may create major carbon monoxide pollution problems because of the auto traffic they generate, and may be subject to Complex Source Regulations under the Clean Air Act.

Controlling The Effects

Controls designed to minimize the impacts of highway-induced development must either reduce the amount of developable land or change the access provided to it. Land use controls such as zoning, which reduce the amount of developable land, were discussed in Chapter 1. Changing the highway capacity or service area often can also be an effective

tool in minimizing adverse impacts.

Reducing the highway's capacity will often reduce the stimulus it provides to land use changes. However, because the highway is usually related to expected needs in the highway corridor, major changes in design capacity are difficult to implement in order to reduce impacts in one particular area.

Changing the service area may be more feasible. Eliminating an intersection may be a practical way to limit development in a community: without the intersection, travel times to the community will be longer, and development will be reduced.

Routing the highways to reduce the amount of land where development could occur may also be desirable. Since the impact areas of highways may be large, it is seldom possible to eliminate development entirely. However, rerouting can reduce demand to a level where growth can be more easily managed.

The detailed design of access around the highway may be very important. Reducing the number of allowed curb cuts may convert strip developments into shopping centers, which could be a preferred mode of development. Changing the number of curb cuts may be especially attractive for small roads, since fewer curb cuts concentrate development and improve traffic flow and safety. The amount of development may not be changed, but its pattern will.

For larger roads, interchange design and frontage roads will be important. Eliminating frontage roads will reduce development along the sides of the highway. Controlling the use of land around the interchanges, especially in the most visible areas for travellers, will also control development. A sign by-law which limits large lighted signs could reduce service stations, for example.

Further Sources

There have been, literally, hundreds of highway impact studies looking at land use, economic, and environmental changes from highway construction.

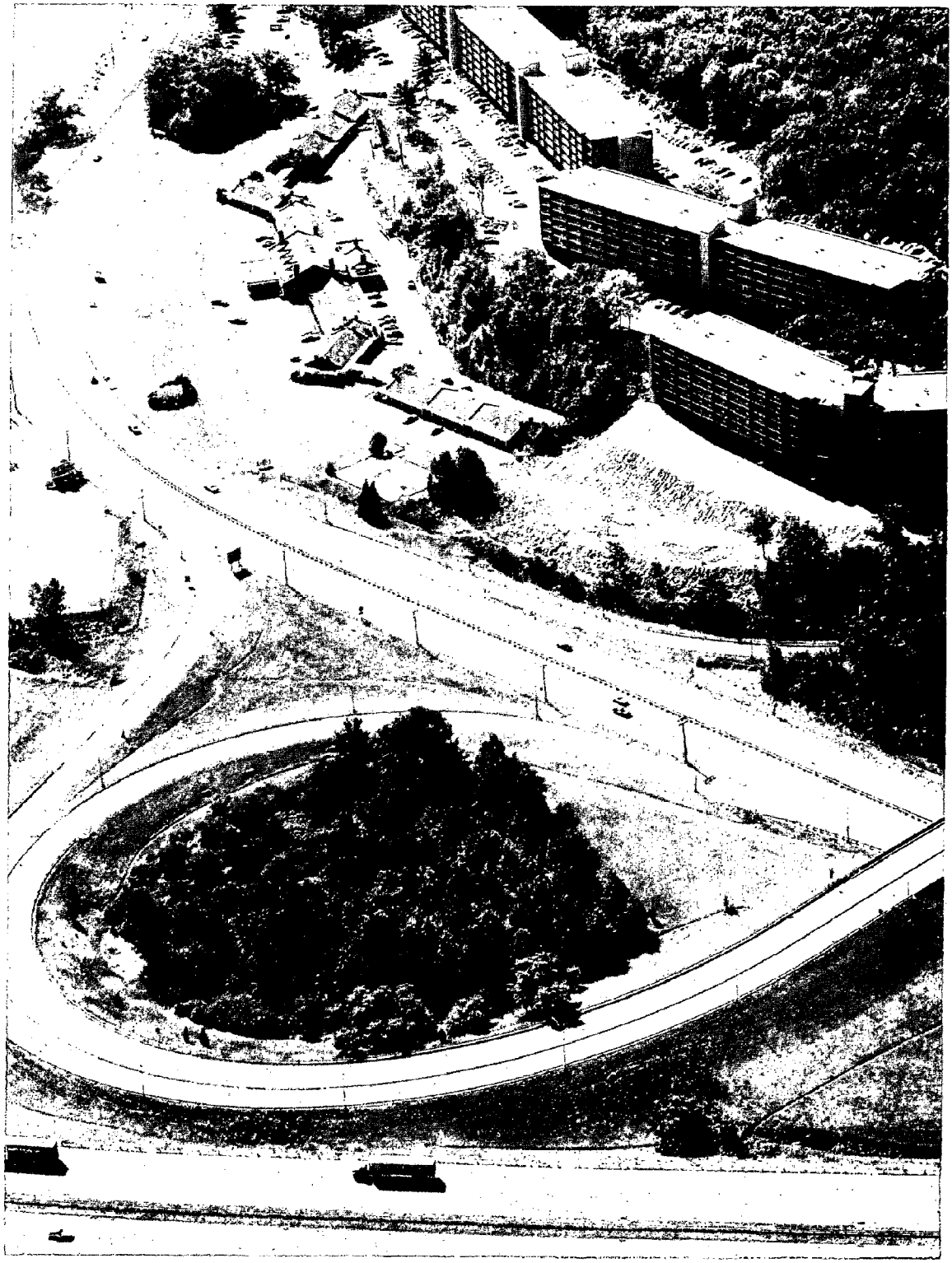
For research on local highways and development, Economics, Planning, or Civil Engineering faculties at local universities often have useful information. The state transportation department and metropolitan planning agencies may also be good sources.

The Secondary Impacts of Sewers and Highways on Development: A Bibliography, prepared for the CEQ, HUD and EPA contains a useful discussion and listing of studies on highway impacts. DOT also publishes summaries of its research on this subject under the title *Socio-Economic Effects of Highways.*

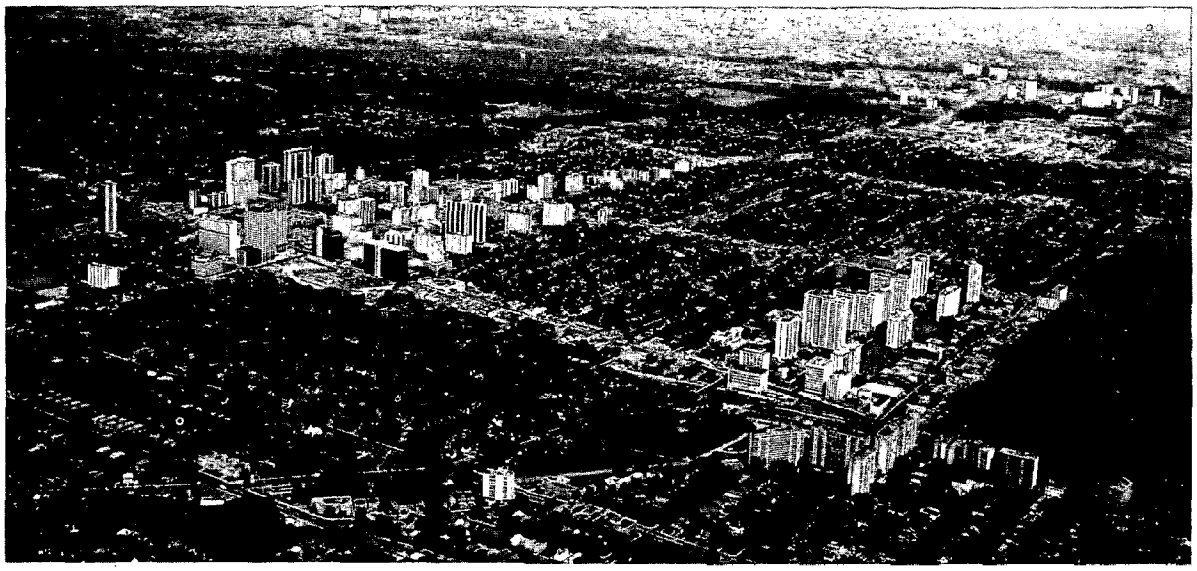
The *Transportation Research Record* and other publications of the Transportation Research Board (National Academy of Sciences), contains a number of studies on highway impacts.

One classic book is *The Urban Transportation Problem* by Meyer, Kain, and Wohl, the outgrowth of a Rand Corporation study on transportation, residential location, and sprawl. It was published in 1965, but is still one of the best introductions to the field. There are also a number of books in the popular press describing the highway decision process and how to change it, such as Lupo's *Rites of Way.*

Specific references used in the chapter include the accessibility analysis of Sherman, et. al.; the by-pass and interchange studies edited by Maiolo; the early Atlanta analysis by Lemly; the classic study of Route 128 around Boston by Bone; and our own experience and what we could gain from conversations with many others.



3 Mass Transit



Toronto, Canada, built its first north-south transit line in 1954 to replace an overcrowded streetcar line going down Yonge Street, the main downtown business route. Since then it has added an East-West line along Bloor and Danforth Streets and expanded both the University-Yonge and Bloor-Danforth lines to the suburbs. Toronto has also been a leader in metropolitan growth in the past two decades, and has built more office space downtown than any city in North America except New York.

Transit has been important in this downtown development and in guiding development in the whole metropolitan area. High density satellite communities have grown up near major transit stations and along routes leading to them. Over 90% of new office construction and about half of the new apartments have been within walking distance of transit.

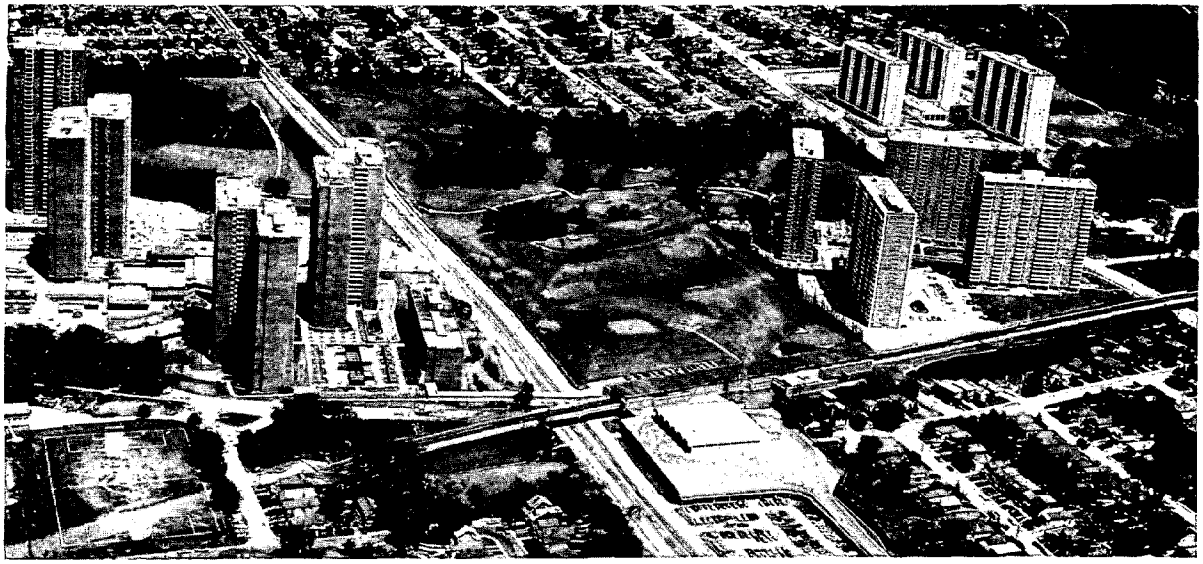
Toronto has sought this type of development. Canada has not provided tax incentives for single-family homes, so apartments have been the prevalent mode of housing. The transit lines have provided density incentives for offices and apartments which located near them; builders have been able to build bigger buildings on smaller lots, and have increased their profits.

The results have been important for the metropolitan area. Downtown is still a major center, and the rush to the suburbs has meant a rush to apartments with good transit service and nearby public open space. Contrary to trends in the United States, Toronto transit ridership has remained high.

The pictures show the sort of development which has occurred. Instead of sprawl throughout the area, development has concentrated around the transit stations and feeder routes to them, and open space has been left nearby.

Translating Toronto's experience to new mass transit systems elsewhere is not simple. The Toronto system has facilitated metropolitan growth and has led to concentrated uses around stations and a viable downtown. U.S. cities, however, have seen thirty years of suburbanization and sprawl, and new transit cannot revitalize decaying downtown areas overnight. The land use effects of

(above) This photo clearly shows a clustering of urban development around two stations of the Toronto transit system. Advance planning maximizes transit benefits in these areas. Source: Toronto Transit Commission.



transit in Toronto have been large, but the effects of new transit lines elsewhere will be slower and less pervasive.

Toronto does, though, show the types of effects which transit creates, and what a policy favoring these land use changes can do. Planners of transit systems should consider whether they want such development around their stations, and what policies to use to attract or discourage it.

Mass transit facilities tend to increase development around their stations. Like highways, fixed-route mass transit systems increase demand for development by improving access. To be economical, they must locate on routes where the daily flow of people is greatest — usually through developed areas to central business districts. Transit is much less flexible than the automobile with which it competes, but its ridership includes the 20% of all households without cars, as well as those who take advantage of its speed and low cost for commuting to work, shopping, and other destinations.

There are several ways in which developers may respond to the increased demand induced by transit. First, a good transit system can be valuable to downtown commercial districts, increasing the development of offices, stores, and other intensive land uses there.

Second, transit can lead to increased density of development around its outlying stations. Areas within walking distance — perhaps one-third mile — of a good transit system can be very attractive both for apartments and for commercial and industrial development.

Finally, transit can also affect the use of land along its route. For instance, a radial transit line from a central city often has "park-and-ride" stations in outlying areas which enable commuters going downtown to park and use transit instead of driving all the way. The transit line will increase transportation capacity along its route giving some improvement in access to outlying residential areas. The result may be an increase in low density development beyond the ring of high density development.

Thus, three land use effects may arise from a transit investment: increased center city development, high density uses around the transit stations, and low

(above) Induced development adjacent to Victoria Park Station in Toronto. Source: Toronto Transit Commission.

density development in areas served by park-and-ride. All of these were shown, to varying degrees, in the Toronto example.

The effect of transit on land use was much larger before the automobile became the dominant mode of travel. But even today, many people still do not have a car available. Most of them live in the cities, and while some are disadvantaged, many who could afford a car find transit fully sufficient for their needs. These households form a "captive market" for transit — they must live where it is available, and they can usually go only where it goes. Because of this, they are a known market for development around transit stations, and their demand for housing and services leads to higher density uses around the stations.

Commercial development will be attracted to busy transit stations. If there is a large flow of people to and from the stations, there is a good chance they will want to shop. For example, a market at a park-and-ride station will get a good amount of trade from people picking up groceries on their way home.

Sam Warner's book, *Streetcar Suburbs,* describes changes in Boston when the electric streetcar came in. People could then travel up to six or eight miles to work. The result was the first real suburban sprawl: between 1860 and 1900 the extension of streetcar lines led to a land boom in new housing. Class differences arose: the upper class moved to the country and commuted by train; middle class people with secure jobs bought homes at the ends of streetcar radials; working class families lived further intown near both radials and cross town links.

Defining the Impact Area

Two impact areas, related to how users reach the transit system, should be defined for transit improvements.

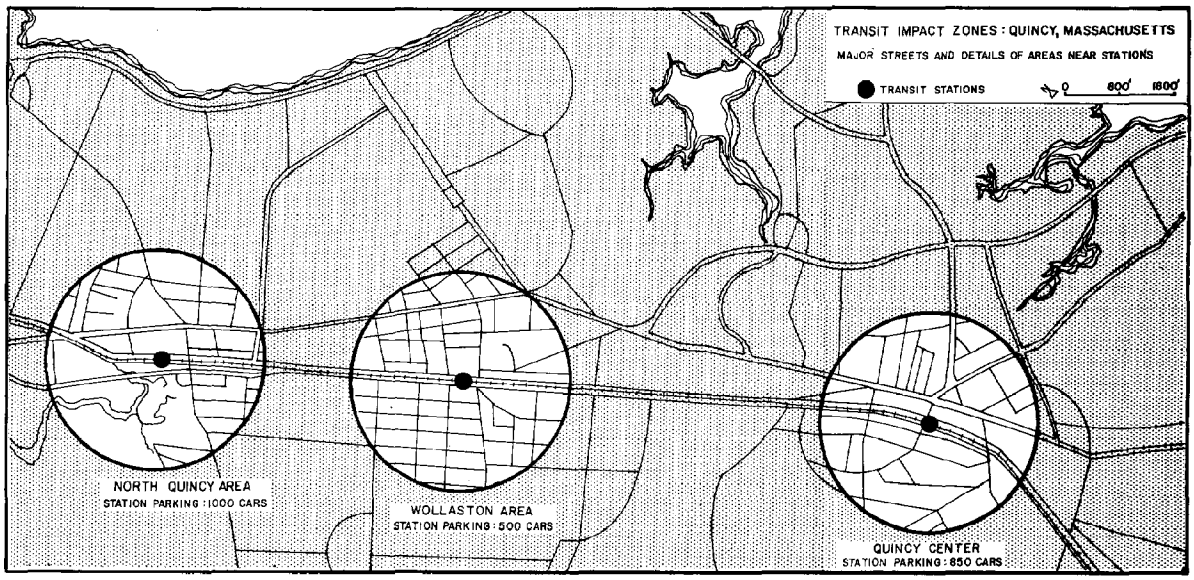
The primary impact area around any station is represented by how far transit users will walk. This distance may vary according to local conditions, but in most cases a circle with a radius of one-third mile around the transit station should include all land in this primary impact area.

The second impact area is in suburban areas served by park-and-ride transit, where transit riders drive their cars to the transit system. Induced development within this area will be low or moderate density, similar to that along a major highway. Some development may concentrate along bus routes feeding into the station, but this will depend on how frequently such routes are used and how firmly they are established. Most of the induced development will be oriented toward automobile travel. The impact area is defined as the area in which the car/transit travel time to the central business district, in the rush hour, is less than that for an automobile alone.

The Supply of Developable Land

The major land use effects will occur in the primary impact area around the transit station. Here, the development demand will be most intense, particularly if there is vacant land available. No buildings need to be demolished in developing vacant land, so site preparation will be cheap and costs low. Only small parcels will be required, since development will be localized and of fairly high density.

After the vacant land is gone, development pressures may turn to land with old or low value structures that can be demolished or extensively renovated to



make new profitable developments. The air rights over the transit line may also be available for development, although costs of construction will be extremely expensive and high rents will be needed to make the development profitable.

In the larger impact area, the important land is largely the vacant developable land considered suitable for large scale, low density uses. The major land use effect of mass transit will be the conversion of vacant land to typical suburban apartments and single-family housing. Redevelopment to higher densities is unlikely, except possibly along major feeder bus routes or in areas with good transit and highway service.

Because the size of the primary impact area around a transit station is limited, competition will cause the more profitable land uses in this area to displace less profitable ones. This may reduce the local diversity of land uses: residential areas will tend to become more intensely developed with apartments (and supporting commercial development), shopping areas will attract more and larger retail outlets and may displace existing older development, and business districts will expand.

Demand for Development

Quantifying increased development demand related to new transit investment is difficult. Each system is unique and there is little experience to go by. As with highways, the general effect of transit systems is to increase demand because they increase accessibility. Such factors as regional growth and local attractiveness are also important.

The extent to which a rapid transit system increases demand depends upon its likely impact on travel habits, which in turn depends upon the ease of using highways and other transportation modes. The demand for travel along the transit route is also an important influence. Where auto travel is relatively easy, or where origins and destinations of travelers are spread out, the rapid transit system is likely to attract relatively few riders and generate a relatively low demand for development. Thus, the same conditions which lead to a successful transportation system tend to cause the system to have a high land use impact.

These conditions are particularly true for the primary impact zone. If there are lots of people riding on the system

In 1971, the Massachusetts Bay Transportation Authority opened a rapid transit link from Boston to Quincy, Massachusetts. The extension has had different impacts on land use at its three stations. In largely undeveloped North Quincy, a major commercial/industrial complex has been built. Wollaston station serves a residential neighborhood of low to medium density with little undeveloped land, and commercial and apartment developments are also occurring. In Quincy Center, (pg. 46) the terminal facility has begun to bolster existing commercial land uses.

there will be a high demand for apartments and commercial developments to serve them. Non-manufacturing businesses will also be attracted to stations, and the system will tend to stimulate the type of development which it best serves. Over time, the development around the stations will tend to attract more riders, which will increase the demand for further development.

Many businesses, such as insurance companies, require access to large numbers of employees, so they generally locate in the central city. Office development here is likely to increase if access is improved, since employee parking is presently a limiting factor for central business district development in many cities.

However, industries may move from the central business district because of transit. Space becomes expensive in the city center because of the high demand and it may be cheaper to move ten or twenty minutes travel away on a transit line than to stay in the city. Thus, there may be some demand for industry development along the transit line, if the level of service is high.

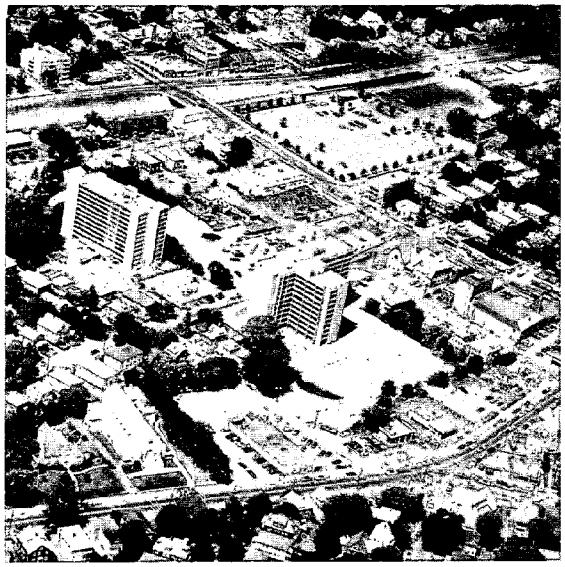
In the lower density impact area of outlying stops, the impact on demand is determined by the drive plus wait plus ride plus walk time compared to the time required for driving directly to the destination. Significant park-and-ride use will be made of the transit only if it is as fast and as cheap as driving to work, although some people like the ability to read or work while riding. The demand for this type of development also depends upon the extent to which employment is concentrated along the transit route and the rate of regional growth.

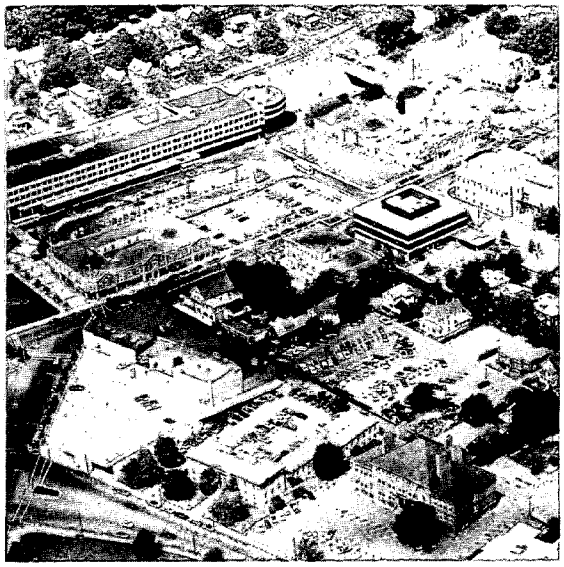
Forecasting Secondary Effects

This section will concentrate on the impact area near the transit station. Land use changes in the outer impact area can be considered using the procedure suggested in the highway chapter. These changes will probably be small, except in special cases which can best be identified locally.

Since transit lines are usually routed to serve existing people and jobs, the area around most stations will usually have been developed already. Near these

(above) North Quincy office development visible in upper left, station in center.





stations, new development may be a slow process. Early changes are likely to be infill housing, splitting of residences into apartments, and conversion of buildings from residential to commercial use. Larger apartments, stores, and office developments will follow slowly, if the demand is moderate to high.

A new transit system may also have stations built near undeveloped land, either at the outer limits of the line or at sites between older developed areas. At the outer end, apartment developments, shopping centers, and other suburban high density construction are likely, as happened in Toronto and Cleveland, where there was some suburban development on the airport extension line. Nearer the city, there may be an important shift of jobs from the center city to transit stations, as in Quincy, Massachusetts. This will depend on the demand for office space in the central city. Both of these types of development can occur quickly, even before the transit investment is completed.

Areas in the central city may also be influenced by a new transit system. If it brings many more people to the city for jobs or shopping, there will be a further increase in development density. But this may require a large investment on the same level as BART, the Toronto System, or the Washington METRO. Even then, the market for office space depends on a large number of factors, and the effect of transit is only one. Transit can concentrate demand for new development, but it cannot create it.

These three cases — the outlying developed area, the outlying undeveloped area, and the central city, show the ways in which transit can affect land use change.

The Resulting Impacts

Transit investments improve transportation and access particularly for the poor and for non-drivers, it can also reduce auto travel and pollution from cars.

The induced-development related to transit can accentuate these impacts. As density rises near stations, more people will use the system instead of their autos. Housing built near stations will be con-

(left) Wollaston station area; apartments are housing for the elderly, station is at top with parking lot.

(above) Quincy Center area; station and parking garage in top left.

venient for non-drivers. Further, the high-density commercial and apartment developments will usually contribute more in taxes than they require in services because of the small number of school age children in apartments compared to single-family homes.

There are, however, some special impacts related to various types of transit investments. The concentrated development near stations will increase noise, traffic congestion, and localize air pollution. The character of the community may also be changed from suburban or local commercial uses to major high-density intense uses. These impacts should be considered in designing the transit investment.

Studies from 1920 to the present have found that transit improvements will do little to counter the decline of an area. In Cleveland, the main transit line runs on old rail rights-of-way through industrial areas and depressed neighborhoods. Little transit-related development has occurred. Camden, New Jersey, is on the Lindenwold line between Philadelphia and several suburbs. The line may have helped commercial establishments in Philadelphia, but it has led to a slight exodus of commerce from Camden, and to development east of Camden.

Controlling the Effects

Much attention is currently being given to rail rapid transit as a way in which to lure travelers from excessive reliance on automobiles. High density development around transit stations is thought desirable since it increases transit use. Land use controls are often used to concentrate development into high density uses around the transit station instead of sprawled throughout the area.

Zoning is commonly used to do this, particularly by zoning areas near transit for higher densities (in terms of area of floor space compared to lot area). This has been done in Toronto and San Francisco, for example.

Another method is to encourage the development of the air rights of the transit system. This can provide more housing and jobs, and thus lead to increased ridership.

Modifying the transit investment can change its land use effects. For instance, if the stations are close together, the land use effects will be smaller around each one than if they are far apart. The route of the system and the location of the station will determine how it reinforces or interferes with existing neighborhoods. If the line is built ahead of development, new growth may occur at its outlying stations rather than along its route.

Finally, the station design and the provision of parking are most important factors. If the station is not designed for pedestrian access, there is likely to be little development nearby. Large parking lots and kiss-and-ride loops may induce relatively more low density suburban development. If the station serves as the starting point for bus distribution, land use change along the bus routes may follow. The detailed flow patterns of people and cars around the station may make development attractive or unattractive, and should be carefully considered in system planning. This is also the portion of the investment decision most amenable to local control.

Further Sources

Most of the major transit systems have done impact studies related to land use, and others are under way. Work on early transit system by Warner (*Streetcar*

The Market Street area is the center of San Francisco's business district, but its importance was declining up to a few years ago. Before the advent of the Bay Area Rapid Transit system (BART), downtown was capturing only 30 percent of all office construction in the area; after BART, the rate is up to 60 percent. Market Street has become the most attractive area for new construction in the region.

Zoning regulations were changed to complement the BART system, by providing density bonuses for buildings near stations, especially for buildings with special entrances to BART. Since bigger buildings could be constructed on land near BART, development was attracted and densities increased.

The whole region has combined to aid BART and increase density around it. For example, the Berkeley City Council turned down a shopping center partially because it was not served by BART and downtown Berkeley was.

Suburbs: The Process of Growth in Boston 1870–1900, 1974) and Spengler (*Land Value in New York in Relation to Transit Facilities,* 1930) are valuable for historical perspective on how land use changed with the advent of streetcars and early subways.

The two most studied systems are Toronto and the San Francisco (BART) systems. Papers on the Toronto System are available from the Toronto Transit Commission and other sources (Heenan, 1972). Studies of land use change before the opening of BART were done by Lee, et al (1973) and post-opening studies are in progress. Progress reports should be available from the Metropolitan Transportation Commission, Hotel Claremont, Berkeley, California 94705. There have also been studies of Boston (e.g., Metropolitan Area Planning Council, 1973; and Kalauskas, 1974), Philadelphia (e.g., Boyce et al, 1972 and Gannon and Dear, 1972) and other cities (see Libicki, "Land Use Impacts of Transit Improvements", 1975).

Two useful general sources are *The Secondary Impacts of Highways and Sewers on Development: A Bibliography,* by Environmental Impact Center, Inc., and *The Economic and Social Impacts of Investment in Public Transit* by Sheldon and Brandwein.

Major transit investments usually require an environmental impact statement, and this may be a valuable source of information.

The definition of the local impact area of transit as one-third mile around the station came from studies of how far people walk to transit stations (see Wilson, et al; Peterson; or MAPC, *op. cit.*). Air rights have been developed in Cleveland suburbs (Libicki, *op. cit.*). Discussion of the transit captive population may be found in Meyer, Kain, and Wohl's *The Urban Transportation Problem* (1965), and other sources.

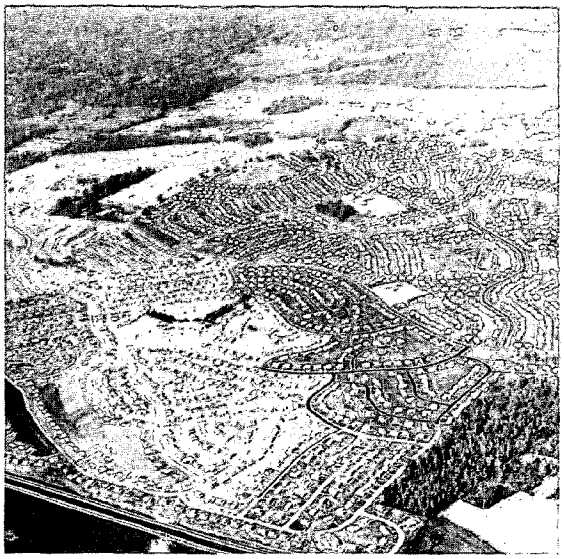
4 Sewers

The relationship between sewer construction and residential housing construction is dramatically illustrated in Fairfax County, Virginia. Lying to the west of Washington, D.C., Fairfax County is a rapidly growing residential community for government workers. In 1963, the County published "A Western County Development Policy," (which pointed out that sprawl development raises costs of government services to taxpayers) and recommended the adoption of "urban satellite clusters" located near the main highway to Washington. Such a pattern of development would save money for the taxpayers and leave more open-space for the enjoyment of residents.

In the following years the cluster concept was consistently defeated by subdivision rezoning and by the powerful influence of the county sewerage system. In 1969, responding to the failure of the cluster concept up to that time, the county planning staff recommended the adoption of "holding zones" in rural areas, where all development would be deferred at least five years. It was hoped that these zones would encourage the satellite cluster concept to take hold, and cut down on leapfrogging, with its high service costs.

A holding zone was approved for the 2500 acre Middle Run area of the Pohick Creek watershed in September 1969. Much to the satisfaction of those wanting to control growth, it was proposed that this zone would not be opened for development until 1975.

Unfortunately, the officials also approved an extension of the sewer system into the Middle Run area at about the same time, supposedly because the funding for this line had been previously approved. The hope was expressed that the sewer would lie idle for five years, but this was not to happen. Within months, rezoning petitions

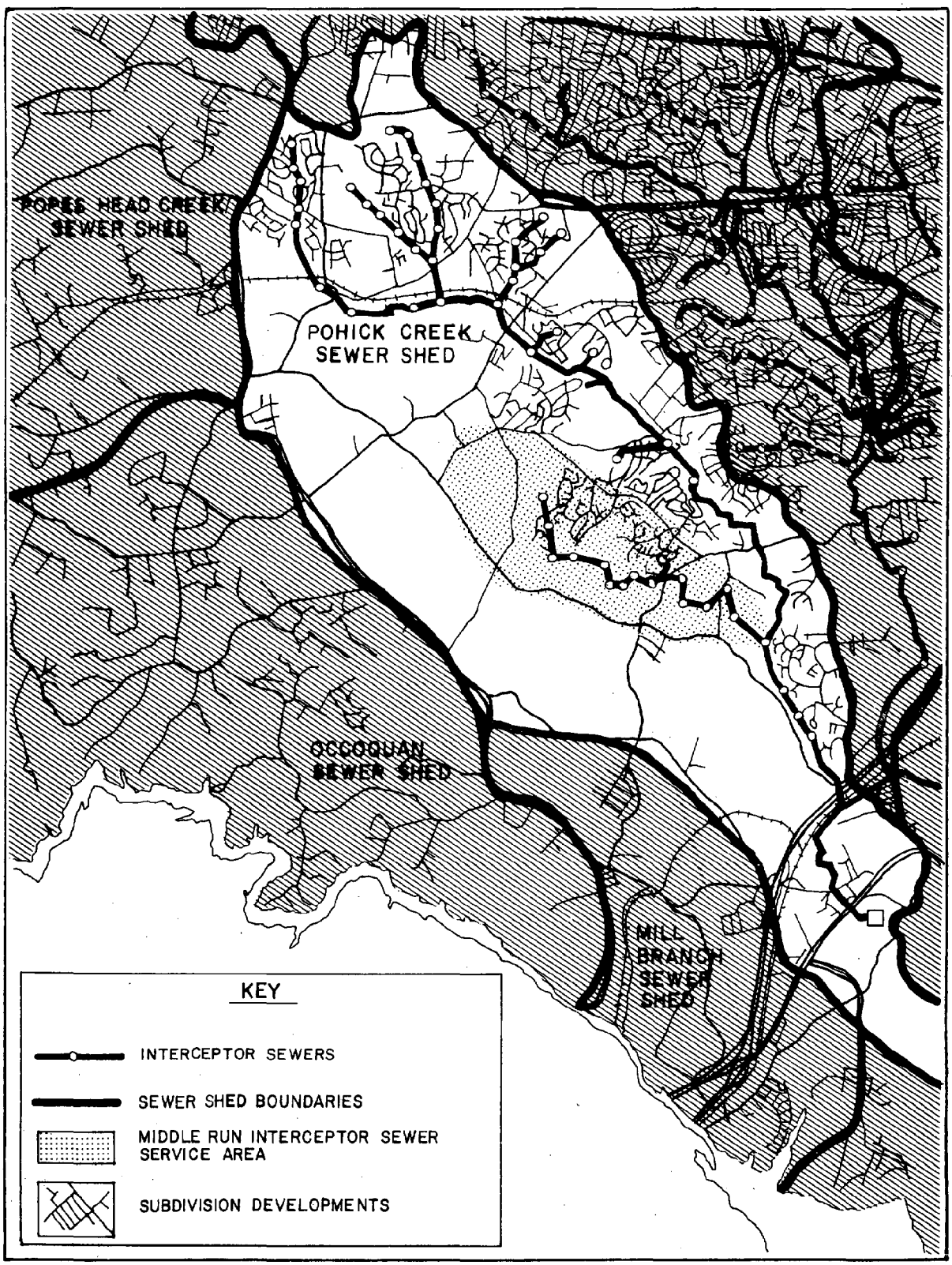


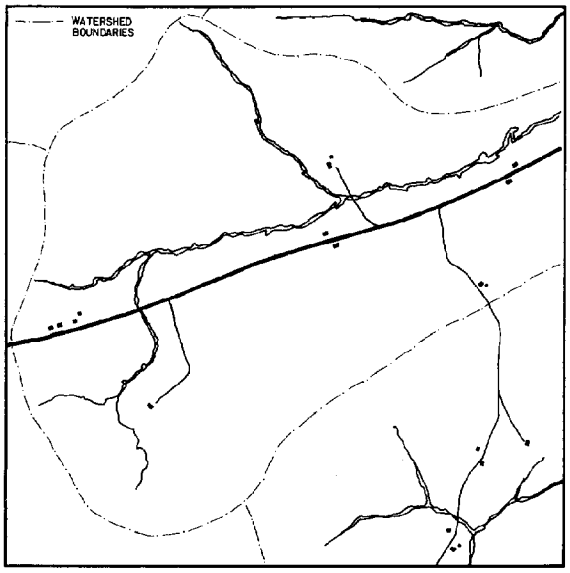
for land within the holding zone were granted and two one-third acre lot subdivisions were approved. There was apparently little that the zoning officials could do. They were under pressure from developers, and, in such a situation, they found it difficult to deny the developers the right to connect to the sewer. Courts feel that access to a sewer, which is after all a public health facility, should not be denied to anyone who wants it. The decision to build the sewer effectively negated the attempt to keep the land from being developed. This episode shows that in areas with heavy growth potential, local level zoning and planning processes often cannot control the development pressures which sewers release.

As the experience of Fairfax County, Virginia, shows, sewers have a powerful effect on the location, pattern, and timing of single family residential development. A variety of studies have found that

(above) Housing development in Prince George's County, Maryland, 1962. Subdivisions like this one are highly dependent on the provision of interceptor sewers. Source: U.S. Department of Agriculture.

(opposite) Development around the Middle Run interceptor sewer, Fairfax County, Maryland, as of late 1973.


POPES HEAD CREEK
SEWER SHED
POHICK CREEK
SEWER SHED
OCCOQUAN
SEWER SHED
MILL
BRANCH
SEWER
SHED
KEY
INTERCEPTOR SEWERS
SEWER SHED BOUNDARIES
MIDDLE RUN INTERCEPTOR SEWER
SERVICE AREA
SUBDIVISION DEVELOPMENTS



sewered, vacant land in suburban communities is worth from two to four times as much as equivalent unsewered land in the same communities.

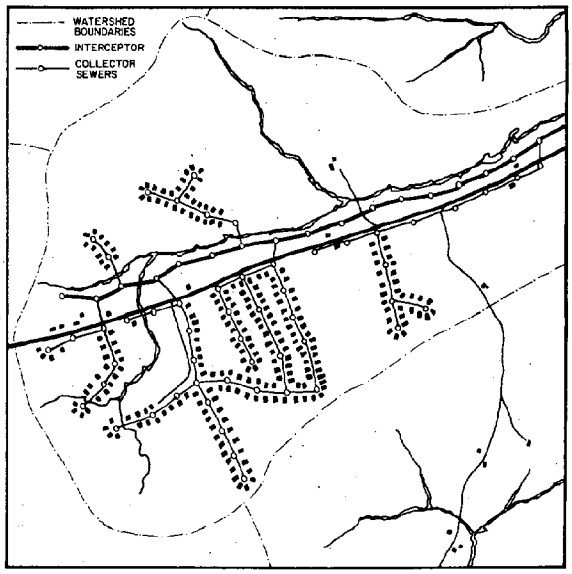
American consumers, supported by tax incentives, have always been attracted to individual home ownership. The land requirements for single-family housing are high, so subdivisions have generally been located on the unpopulated outskirts of cities. In the past, these developments often had no sewers and were dependent for their wastewater disposal on septic tanks. This trend to locate on the urban fringe continues today, but new development is becoming increasingly dependent on sewer services.

New development is attracted to areas served by sewers for a variety of reasons. First, consumers prefer houses with sewers; septic tanks require maintenance and are an undesirable responsibility. Second, increased concern for the environment has prompted the extensive (and expensive) construction of sewers in outlying areas and has made it more difficult to have septic tanks approved in moderately priced subdivisions with lots of one-half acre or less. Third, communities may deliberately attract new development to new sewer service areas in order to pay off construction expenses through user charges and connection fees.

The focus of this chapter is on "interceptor" or "trunk" sewers. These are the sewers that connect the treatment plant with the smaller "collector" sewers serving the individual homes or subdivisions. Interceptors are constructed by local governments, although their cost is usually heavily subsidized (to the tune of 75% or more) by federal and state governments. Developers do not have to tie into interceptors. As an alternative, they can construct small "package" treatment plants (about 10,000 of these plants are built each year) which serve only the immediate development. However, the use of package plants is restricted by many communities. They may not provide effective treatment over the long term if they are not operated and maintained properly, and their full cost has to be paid by the developer. For these reasons developers prefer land served by a municipal interceptor.

(left) Sewage treatment plant under construction, 1975.

In the drawing at left, scattered development is shown along rural roads in a watershed at the edge of an urban region. At right, an interceptor sewer has been built, paralleling the route of a local stream, enabling subdivisions to locate within the watershed boundary. Service is denied to development in adjoining watershed areas, so development which might have located there appears instead in the project service area. Once the sewer capacity is installed, it is very difficult to control connections to them so long as excess capacity exists.



Interceptors are always built with "excess capacity" — that is, capacity beyond that needed to handle the peak flow from the present population of the area served. This excess capacity is available to developers to serve future projects that might connect to the lines. The proportion of excess capacity provided may vary from a low of ten or twenty percent of the used capacity up to several hundred percent. The high subsidies available encourage the construction of large sewers with large amounts of excess capacity for growth. In addition, design criteria for interceptors are always conservative, tending to provide for even more excess capacity through overdesign. So long as excess capacity is available, developers need only pay a reasonable connection fee to satisfy their wastewater management requirements.

The high subsidy rates also tend to favor large projects that open up large areas for development all at once. This tends to promote low density, single-family subdivisions. In federally-funded projects, efforts to promote regional systems often result in several communities being tied together by long interceptors traversing vacant land. Cheap land between existing towns and excess sewer capacity combine to give a strong incentive for development as a side effect of this regionalization. Local communities also often seek to bring sewers to as large an area as possible when they build. Not wanting to interfere with the land market, they seek to spread the benefits of sewers to as many landowners as they can justify. To deny access to sewers could lay town officials open to a suit, for values of property outside the sewer service area may actually decline if they were previously bid up by development speculation.

The two factors, the amount of excess capacity and the amount of vacant land served, are important determinants of the amount and pattern of development resulting from an interceptor's construction.

Defining the Impact Area

To minimize the cost of mechanical pumping, sewers are designed to flow by gravity wherever possible, and are usually built close to the routes of natural streams. Their service areas, therefore, tend to correspond to natural watersheds

One sewer interceptor project was designed to serve the rapidly growing Horn Lake Creek Drainage Basin in the Tennessee/Mississippi interstate area near Memphis. The engineers first projected a population increase from the original 34,000 in 1974 to 208,000 in the year 2000. For the Mississippi part of the area, one engineer predicted the ultimate population would be 265,000; another predicted 337,000. The estimates were never reconciled, but the higher one was used. The final design had enough capacity to serve 410,000 people, twelve times the initial population.

— development outside of one watershed cannot connect to a sewer in a neighboring watershed without expensive pumping. A "legal" service area may also be defined which limits the area within which connections to the system are automatically granted; connections outside the legal service area but within the watershed boundary can be allowed but require special permission.

Where land is completely flat, as in river delta regions, watershed boundaries do not exist. In these areas, gravity flow is provided entirely by the inclination of pipes in the ground. This limits service area size severely, as laying pipes at depths greater than 14 feet is prohibitively expensive. Mechanical "lift stations" must be built to transfer sewage between segments of inclined pipe in flat service areas.

Where watershed boundaries are defined, they represent a project's impact area. Legal service areas, even if they are smaller than the watershed area, seldom curtail development because connection permits are usually easy to obtain. Where watershed boundaries are not defined, the impact area may be defined as all land within 1000 feet of the sewer. It is also important to consider the vacant land opened by regional projects in which a series of watersheds may be tied together by cross-country interceptors.

The project engineers are best able to define the service area, and usually provide this information on maps showing the sewer's legal service area and watershed boundaries. Sewer authorities will have information on the procedures for obtaining connections to the sewer system by development outside the legal service area.

The Supply of Developable Land

Sewers affect land use predominantly by increasing the supply of developable land. The amount of increase depends upon the amount of vacant land the sewer serves, and its excess capacity.

As mentioned in Chapter 1 and in the preceding sections, the amount of developable land is determined by physical, legal, and economic factors. Even though it lies within the service area, steep slopes are not likely to be developed unless there is a very high demand. Sewage collection facilities serving homes on steep hillsides can be expensive to construct. Land that lies in particularly low areas, below the service level of the sewer, is effectively excluded from development.

Legal restrictions may eliminate some of the land from development if it has been set aside in parks, wildlife refuges, and so forth. However, as pointed out at the beginning of this chapter, zoning by itself is unlikely to keep an area out of development if sewer service is available.

Economically, sewers are unlikely, by themselves, to stimulate redevelopment except in instances where the existing land use is of particularly low value (possibilities include sites containing marginal industries and scattered inex-

The city of Tulsa, Oklahoma, and its suburb, Broken Arrow, share rapid economic growth. Long an important oil town, Tulsa has diversified and continues to grow. An expressway was built to Broken Arrow to help commuters to reach the central city. Despite the heavy demand for residential development on the intervening land, environmental considerations required new sewerage capacity before development could start. When federal funding for sewers became available rapid development occurred on land which previously was almost vacant.

pensive homes). Sewers typically have their greatest impact on the construction of single family homes, and these are most likely to be built where there are large tracts of undeveloped land. The construction of a sewer will make such sites suitable for medium (two dwelling units per gross acre) and higher density development, where it otherwise would only be suitable for lower density development.

If there are relatively large amounts of such sewered vacant land already, the construction of a new sewer will have relatively little impact on supply. If the supply of such land is tight in the area, the construction of a new sewer can have significant impacts.

Demand for Development

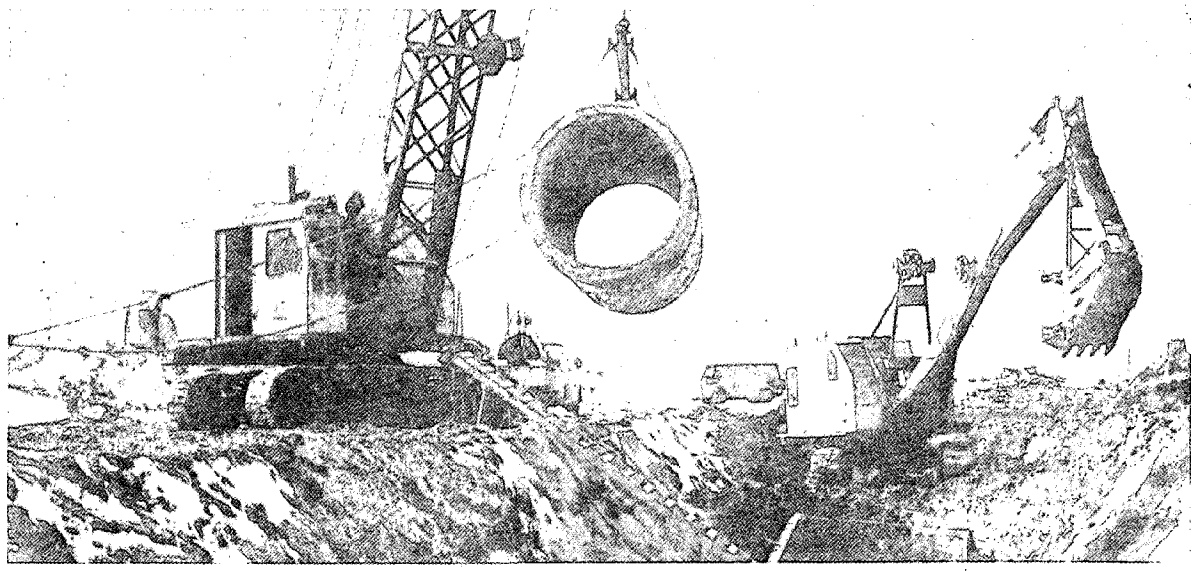
Demand for development within a sewer service area is unaffected by the construction of the sewer itself. Estimations of development demand may, therefore, be carried out as discussed in Chapter 1, without any special additional considerations. Demand estimation should include consideration of the local vacancy rate, the condition of local housing stock, recent land transactions within the project impact area, the quality of local amenities, and the amount of sewered, developable land available elsewhere in the region.

Forecasting Secondary Effects

If the sewer services extensive amounts of vacant land, particularly when the individual parcels are large, the induced development is likely to be low density. Significant amounts of leapfrogging will also occur as developers search for the lowest priced available parcels, which are likely to be far away from existing development. Little infilling will occur initially because it is easier for the developer to start fresh with a large piece of land rather than fit the housing in with existing development, and because the price of land in partially urbanized areas is typically higher than it is at the urban fringe. The rate of development will depend predominantly on how much demand there is for development, and how much other sewered, vacant land is also available.

If the sewer opens up only a moderate amount of vacant land for development, the pattern of development is likely to be somewhat different. There will be more infilling, and less opportunity for leapfrogging out into rural areas. The price of land in the service area will be somewhat higher, and as a result, the development will be somewhat denser. All in all, the development will be more compact and of higher density particularly if the demand for development is high. If the demand is only moderate, the land prices will not increase as fast, and, therefore, development will be of lower density, but still not as low as in the previous case.

Oddly enough, if the investment is not made at all or if it opens up very little vacant developable land, the effect may



again be to stimulate leapfrogging. This is because the land in the service area will become so high priced that it will pay the developer to go outside the service area for cheaper land even if he has to build his own package treatment plant. If the developer is doing this, he is unaffected by the location of the sewer and will look for the cheapest land available, which is likely to be significantly beyond the bound of existing urbanization.

Thus, it is primarily the relative supply of vacant developable land opened up by the sewer than determines the pattern and density of residential development. The relative demand has some affect on these two factors, but a bigger effect on how quickly the development occurs.

The construction of sewers *per se* usually has little direct impact on commercial or industrial development. In both instances, other factors are likely to be much more important, and the facilities can usually afford to build their own wastewater treatment plant if other locational advantages exist, but there is no public sewer.

The Resulting Impacts

Sewers are built expressly to handle an environmental problem — the disposal of community sanitary wastes. They are intended to prevent contamination of surfaces and ground waters from improperly functioning septic tanks, guard against disease, and transport wastes to locations where they may be treated and safely discharged. Ironically, by tending to attract extensive development, sewers may create several environmental problems in solving one.

Sewers, like highways, can lead to the conversion of large areas of land to residential development. This development often causes serious sedimentation and erosion problems, both from construction activities and from the creation of large areas of impervious ground surface (rooftops, roads, driveways, parking lots, etc.). Air pollution is aggravated due to increases in local traffic and the burning of fuels to heat houses. While ground water quality is protected by the use of sewers, local stream quality may actually

(above) Sewer under construction, 1970. Source: Waterworks and Waste Disposal Division, Winnipeg, Manitoba.

In its wild state, Tahoe was a lake of matchless clarity and beauty. But many homes and lodges were built near it, polluting the waters with sewage. Nevada's government went to lengths to build facilities that provide advanced treatment for the sewage. The natural resource was thought saved.

However, these facilities permitted more motels, apartments, and casinos to be constructed. Although pollution from sewerage is now small, increased eutrophication, scenic degradation, and air pollution have completely changed the area.

be degraded by the release at a single point of large quantities of treatment plant effluent, and by the increased stormwater runoff.

The economic impacts of sewer construction may also be large if there is rapid local population growth. These are discussed in detail in Chapter 1. The provision of municipal services (especially schools) and physical facilities (roads and water supply) will put a heavy additional financing burden on developing areas.

Controlling the Effects

To reduce adverse impacts of induced growth due to sewer projects, the project may be modified in several ways.

Reducing the capacity of the sewer pipe itself reduces the ultimate population the project may serve. Often interceptor sewer projects are sized according to the zoning of the service area, on the assumption that the area will become totally developed as zoned. Such population projections may become self-fulfilling and lower population projections are often equally reasonable. Reducing the capacity of the lines to serve only the existing population prevents induced development, but a rational community land use policy usually should provide for some growth.

Reducing the capacity of the system does not necessarily reduce environmental impacts an equal amount. Large amounts of land can still be developed, though at a lower population density. Therefore, reducing the size of the service area may also be necessary. Shortening the length of lines is a practical constraint on land development: though all land within the project watershed may technically be able to use the interceptor, developers will be reluctant to lay long lines of their own to connect. The interceptor's capacity and length may be adjusted to encourage localized higher density (multi-family) development, or consolidated areas of single family development. Both control techniques also reduce the costs of the project to the community.

Breaking down a project into successive stages of construction is also useful, and has two side effects. First, it confines immediate development to smaller areas and reduces leapfrogging. Second, the resulting population forecasting period is shorter; it therefore allows for more accurate population projections, and gives flexibility if population growth departs from predictions. Such phasing, if intelligently planned, is unlikely to increase project costs significantly. Any increased costs should be balanced by the benefits of better community planning and a lessening of the immediate financial burden of the project on present residents. It is likely that some sort of clear schedule for phasing will be required by the courts if this alternative is implemented.

Where the impacts of a sewer project will put a severe strain on a local community, a moratorium on all sewer construction is sometimes imposed as a last resort. This effectively halts all new local development until more sewer capacity is built. Such moratoria remain highly controversial as growth control tools: some communities have used them in bad faith to prevent the construction of multi-family or low income housing, and they may cause developers to build scattered developments beyond the urban fringe where the land is cheap enough to compensate for the need to construct a package treatment plant. Nor are courts likely to permit such moratoria to remain in effect for more than one and a half to two years.

Further Sources

Interest in the link between sewers and land use conversion has emerged only comparatively recently, so the existing literature is slender.

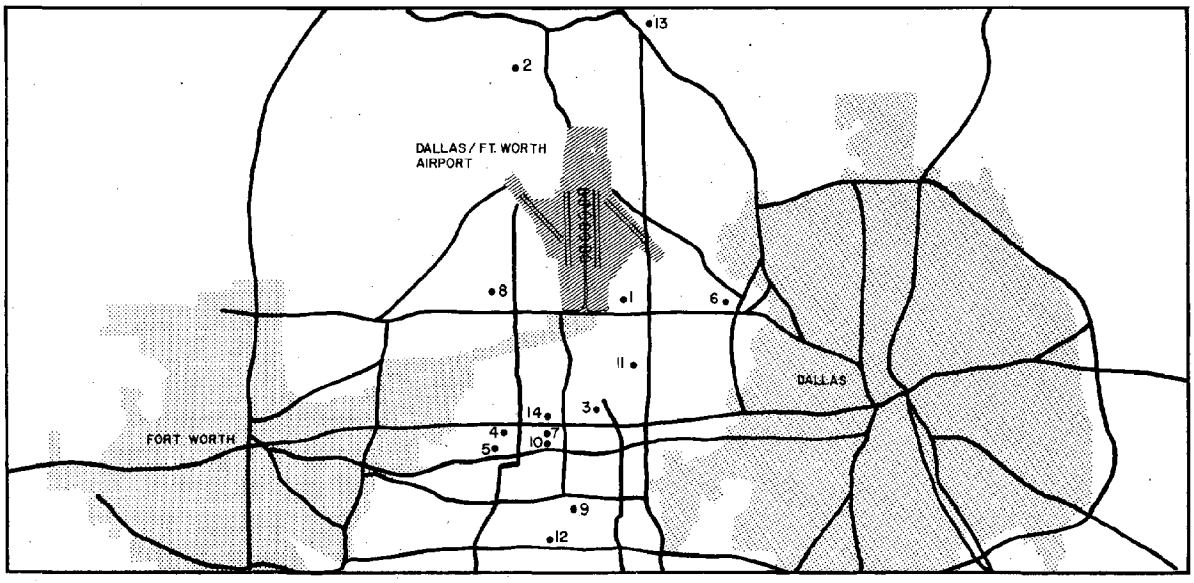
The introductory example for this chapter was taken from Jeffrey Stansbury's article "Suburban Growth — A Case Study" (1972). Despite its sarcastic view of the role of local government in urban development, this piece has received widespread circulation and gives an enlightening view of the dynamics of suburbanization's dependence on sewers.

A 1974 study by Urban Systems Research & Engineering, Inc., *Interceptor Sewers and Suburban Sprawl,* also includes a number of case studies. *The Secondary Impacts of Highways and Sewers on Development: A Bibliography* by the Environmental Impact Center contains further references.

EPA expects to increase the number of Environmental Impact Statements it prepares on sewer projects, and is presently revising its project design guidelines, and preparing a manual for predicting secondary effects, to stimulate better consideration of sewer induced development in project planning.

(opposite) A 54 inch interceptor sewer being constructed in Stratford, Conn. in 1973. Source: CE Maguire, Inc.

5 Other Infrastructure Investments



Highways, mass transit, and sewers are the most common, but not the only, infrastructure investments having strong effects on development. Other types of investments, such as those introduced in this chapter, can also induce significant local development. This process will not be described in detail here, but the general methodology for assessing likely impacts, used in the previous chapters, can also be applied to them. If one understands how an infrastructure investment affects the supply of developable land and the demand for development, one can estimate the development that will be induced by it.

One type of investment that can have a large impact on development, similar to that resulting from sewer investments elsewhere, is the provision of water supplies. In arid regions, the water requirements for development and the analysis of their impacts can be carried out in essentially the same manner as that described for sewers.

The remaining sections of this chapter describe a number of other major types of investments.

Airports are the topic of the first section. Airports attract development of several kinds, but impose strong negative impacts on nearby areas in the form of noise, air pollution, and traffic.

New employment centers can have important land use effects, and can have important secondary financial impacts on communities, inducing additional development. These issues are discussed in the second section.

Parks, recreation or entertainment facilities can promote second home developments, and require housing, transit services and support for employees. Recreational development can impose heavy costs on local government, and can have major environmental impacts on the sensitive ecologies typical of such areas. These are covered in the third section.

The next decade will see a large amount of investment in energy facilities such as mines and power plants. These facilities have often induced "boom-town" growth in remote rural areas, with severe social, economic, and environmental impacts; they are discussed in the fourth section.

Flood control dams are the topic of

(above) Development sites near Dallas/Ft. Worth Airport. Source: *Business Week*, adapted by Urban Systems Research and Engineering, Inc.

Development near Dallas/Fort Worth Airport

1. Metroport, a $125-million office complex
2. Flower Mound, a 4,500 acre new town
3. Lion Country Safari
4. Seven Seas Amusement Park
5. Turnpike Stadium (baseball)
6. Texas Stadium (football)
7. Six Flags Over Texas Amusement Park
8. Bedford Forum, 716-acre commercial and residential development
9. Forum 303 shopping mall
10. Six Flags Business Park (500-acres, $250-million)
11. Harbor Lakes, 379-homes
12. Century 21, 311-acre, $150-million residential and shopping area
13. Lewisville Valley, 1,300-acre, $200-million residential, commercial, and industrial development
14. Brookhollow/Arlington, a 270-acre business park

the last section. They can promote extensive construction in the areas they protect from flood damage, though these areas are often environmentally unsuitable for development.

Airports

The new airport serving Dallas and Fort Worth is without precedent in the scale and amibitiousness of its design. It is also the only major new airport to be constructed in the country in recent years. Though its planners took unusual pains to anticipate and control secondary impacts of the airport, the project is so large that growth in the airport region has been feverish. According to one major landholder, "The airport is probably the most important significant project in the U.S. in the last 20 years in terms of its impact on real estate values."

Homes, offices, motels, warehouses, stores, industrial plants, and recreational facilities have sprung up in the 35 mile wide area separating Dallas and Fort Worth. A 4,500 acre new town, Flower Mound, has been constructed just north of the Airport's 17,000 acres. Speculation in land prior to the opening of the airport was frenzied: values multiplied by ten times in the five years prior to the project's completion.

The irony of this speculation is that the price of land has often risen beyond its potential value for actual development. Some land previously valued at $5,000 per acre cost $50,000 by the time the airport opened. Only high intensity commercial or residential development can afford such high land prices, and the market for office buildings and luxury apartments in the area has not been adequate to develop all these parcels.

As a result, competition for development is intense among the 20 towns and cities of the area. The North Texas Council of Governments is trying to use voluntary acceptance of comprehensive zoning programs to create compatible land uses and balanced economic bases for new communities serving the airport, but the obstacles are great. Communities lack money to build the extensive sewers, roads and utilities necessary to support balanced communities, and are tempted to zone unwisely to maximize their immediate revenue needs. A disporportionate amount of land has been zoned for commercial use, and much too little for

parks and other open space. In many communities, the airport itself removed large amounts of land from the tax base.

While a great deal of land has been zoned for high density use, it does not all lie along planned transportation corridors. Local roads are as yet inadequate to serve these areas efficiently, and the unplanned dispersed pattern of development makes the contemplated development of a rail rapid transit system an inefficient solution to transportation needs.

In short, for all the economic benefits the Dallas/Fort Worth Airport has provided already, it has created many long range problems for successful regional development. While the attempt to prevent development on the most noise-affected areas by including them within the airport boundary showed vision, more effort could have been made to assist compatible development around the site.

Airports have far-reaching impacts on the economic life of communities, as the experience at Dallas/Ft. Worth points out. They may also impose serious adverse impacts on adjoining areas because of noise, air pollution, and commercial growth. Certain land uses are compatible with airport impact zones: noise-proofed offices, hotels, retail outlets, industries, and certain indoor sport facilities are the main ones. Other land uses are incompatible; these include schools, hospitals, churches, parks and all types of housing.

It is very difficult to redevelop land in the airport environs to compatible uses for two basic reasons. First, most airports are located within at least partially developed areas, where the existing mix of land uses may be incompatible with itself as well as with the airport. Since they are employment centers, airports often have created significant concentrations of nearby employee housing. Until the late fifties, when jets were introduced and commercial air traffic expanded, noise and air pollution impacts in these local areas were tolerable. Since then, local community dissatisfaction with airport operations has risen. Simultaneously, many airports have increased their operations and expanded their runways to accommodate bigger planes, compounding the problem.

While studies have differed over the impact of airports on local land values, residents fear that their properties are devalued relative to the rest of the region. They feel locked in because they often cannot move. The cost of redeveloping entire impact areas to compatible land uses is a tremendous undertaking that cities usually cannot afford. Tax relief to area residents to compensate them for their economic, environmental, and psychological burden has been suggested, but is not really a solution.

The second obstacle to compatible land use seems paradoxically opposite to the first; it is the competition among towns abutting the large airport land holdings for airport-associated development. Some commercial and industrial facitities making extensive use of air transportation for deliveries will try to locate next to the airfield. Hotels, motels, car rental offices and other commercial undertakings serving the traveling public are also willing to pay high premiums for airport sites. However, the market for passenger service sites is small, and is usually confined inside airport sites and along access roads; also competition to sell land to the few airport-related manufacturing firms is often so great that land prices in nearby industrial zones are not significantly different from those of other industrial land in the region. As is true near the Dallas airport, much more land is likely to be zoned industrial than can be sold for industrial purposes.

The most powerful way to control

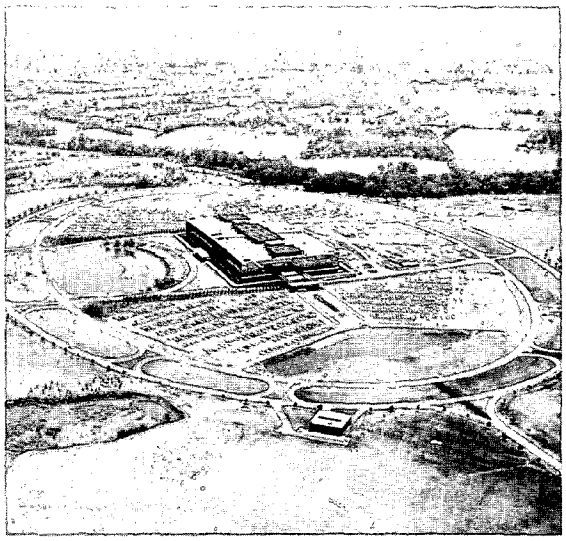
land use around airports, provided the land is presently vacant, seems to be advance land acquisition. If development already exists, land must be purchased by a redevelopment authority, and the structures demolished. The property must then be resold (with restrictive use covenants), or leased to industry or commerce, so that the airport authority controls nearby development instead of just forcing it further away. Since commercial and industrial land usually has a low rate of absorption, revenues for sale or lease will be slow coming in.

Industrial and Commercial Centers

Industrial and commercial centers have the potential to induce urbanization, as was clearly demonstrated in the Green River Valley outside of Seattle, Washington, in the late 1960's.

In 1965, the Boeing Company chose to locate a new aerospace center, totally isolated from any existing urban development, in the middle of a cow pasture in the town of Kent. It then requested that Kent provide a water distribution system. Ostensibly to optimize the economics of water distribution, Kent designed its system to service approximately five square miles of land, and declared a Limited Improvement District assessment of $1,000 per acre. This assessment was a serious blow to local farmers, who had no need for the level of service provided.

In 1967, the need to provide waste collection and treatment for the Boeing plant encouraged Kent to join the regional sewer district. Major sewers were built, resulting in an additional assessment to land in the Limited Improvement District of $300 per acre. Simultaneously, the charge for sewer service (based on the amount of water used) was increased, forcing all the local canning industries, which used large amounts of water, to leave the town. This exodus removed the primary market for many of the local farmers, dealing them another blow.



The Boeing plant, in effect, has committed at least five square miles of rural land to urban uses. As of 1975, the level of development has not reached the saturation levels implicit in the expensive infrastructure so far installed, but land in prime areas of Kent is now selling at $20,000 per acre. Whether this is good or bad cannot be concluded; it is, though, a very major change brought about by the Boeing plant and decisions related to it.

American urban growth is continuing to decentralize away from major cities. The trend in residential land use continues in the direction of low density, but now it is supported by major industrial and commercial centers within the suburbs themselves. Where commuting to jobs in the central city was once the rule, plants like Boeing's now tend to locate in fringe suburban areas. Even firms with high clerical employment,

(above) Bell Telephone Laboratories, Holmdel, New Jersey, 1966. Source: U.S. Department of Agriculture, Soil Conservation Service.

such as insurance companies, may locate in the suburbs away from mass transit. Similarly, regional shopping malls are supplanting local shopping centers, offering a wider selection of goods plus single trip convenience. The location of these industrial and commercial centers in undeveloped areas has induced additional urbanization.

One example is the small shopping center located outside a rural town. Because of the high use and convenience of automobiles in uncongested rural areas, these shopping centers can profitably locate away from built up areas. They offer new facilities and easy parking, so they often take much business away from existing establishments in town.

But in turn these centers can induce a strip of commercial development connecting them to the town; other new businesses take advantage of the comparatively greater traffic on the access route to the shopping center, causing further erosion of the town's original businesses and the reinforcement of sprawled out development.

Larger industrial or commercial centers have commensurately greater effects. As seen in the Boeing example, the effects need not be based on *realized* economic benefits from these plants: the town of Kent installed infrastructure for expected growth which still has not occurred ten years later. But Boeing's independent decision to build the plant forced the town of Kent into a number of decisions it would not otherwise have made, and committed it to urbanize a prime agricultural area.

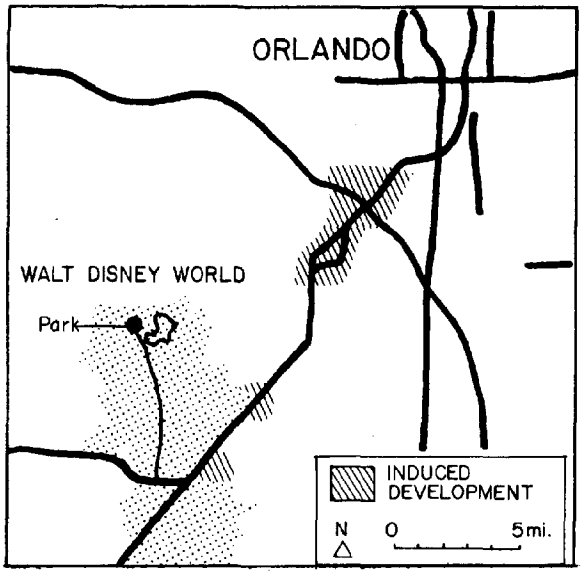
Other employment centers have had major effects: the Kennedy Space Center at Cape Canaveral, Florida stimulated extensive development of Brevard County during the 1960's; the Atomic Energy Commission and the National Bureau of Standards along the interstate highway north of Washington, D.C. have stimulated development along a 60-mile corridor leading to Frederick, Maryland.

The negative effects of employment centers on local communities are intrinsically less severe from an economic point of view than other infrastructure facilities we have reviewed. Economically, they have many positive impacts, increasing local employment and local tax revenues, at least if the community does not overreact like Kent. The environmental and social impacts, however, are still of concern.

The environmental impacts of employment centers mainly come from the familiar sprawl development patterns that they induce. Industrial plants such as Boeing's leapfrog to outlying areas to take advantage of low land prices, virtually committing the intervening land to extensive low density infill development.

The social impacts of these land use change may be severe; the community's whole employment base may shift to

(left) Shopping center development, Newton, Massachusetts, 1966.



new occupations, and population growth may be dramatic.

Controls on the effects of new employment centers must address both the location of new center (to reduce leapfrogging), and the configuration of the secondary development which follows it. Controls on facility location are inevitably controversial: communities do not want to jeopardize potential new tax revenue and employment by imposing unpalatable restriction. Controls on secondary development are less controversial.

Recreation and Entertainment Facilities

When Disney World was planned for Florida, the designers decided to correct a mistake made in Disneyland. Disneyland only included the immediate park area, but its large number of visitors attracted further development which surrounded the park. The Disney Corporation had no control over this development, and could neither require compatible uses nor receive income generated in part because of the existence of Disneyland. Walt Disney World was planned to be much larger (27,000 acres) to allow the designers to control land use and access around the 100 acre theme park. The Reedy Creek Improvement District was authorized by Florida to give the Disney World developers authority to govern and control the larger area.

This careful planning was only partially effective. As planned, access to the park is through undeveloped land on Disney's property. The company has room for its resort hotels, golf courses, airports (a STOL port, and a planned jetport), and new town. But the plan did not control the land use impacts of the park on the regional level.

Interstate 4 from Orlando to Tampa provides access to the park. Over 20,000 motel rooms have been constructed along I-4 since 1970. Leapfrogging apartment developments were built behind the motels on the sites of old orange groves.

Two other major theme parks are nearby — Sea World (with porpoises, whales, aquariums, and so forth) five miles north, and Circus World (planned to be another giant park like Disney World, and the new winter home of the Ringling Brothers Barnum and Bailey Circus) five miles south. To a business serving tourists, the advantages of locating in this area are clear.

As a result of the induced development, I-4 may have to be widened to handle the added traffic, ground water pollution is a major problem, and the provision of services to the unincorporated areas is expensive and difficult. The original efforts to control land use by buying adjacent land were reasonable, but the boom town growth of the Orlando region and the lack of land use control outside Disney's site were unexpected and have to some extent defeated the original intentions.

(left) Orlando/Walt Disney World area. Development shown near all interchanges along I-4.

Not all parks and recreation facilities are like Disney World. Few are built in boom regions like Orlando. But other recreation facilities induce similar development in service industries, housing and other recreation. Service industries are most significant. Tourists need restaurants, lodging, transportation and other services, and these will grow up around a recreation investment, whether it is a ski slope, a park, an artificial lake or an historic village.

Housing comes next. Part of the housing will be second homes for the skiers, fishermen, or others who use the area. If the recreation area is big, housing will have to be built for employees working in local service industries.

Other recreation investments may follow the initial one. Disney World has been joined by Sea World, and may be followed by Circus World as well. A successful ski area may expand or be joined by others on nearby mountains. A park may be surrounded by animal farms, dude ranches, or other tourist attractions. All combine to increase the amount of regional development.

The impacts of these developments can be as large as any of those discussed above. Since they often occur in rural areas, they can transform (or even control) the local economy. Seasonal facilities may lead to summer populations several times larger than winter populations, or vice versa.

Many recreation areas occur in environmentally sensitive areas, such as lakes, rivers, coastal zones, and mountain tops. Development of these areas may have serious ecological impacts, and may even destroy the natural amenities which produce recreational value.

Control of these facilities is difficult. They tend to be built in rural areas which have no experience with land use controls. The positive impacts — tourist dollars — are stressed, and the fact that these dollars may go to new residents and that service costs may rise is ignored. Effective control may be impossible except at the state level, although local governments still have the authority and responsibility to analyze carefully the potential impacts of individual projects which are proposed. Many recent land use controls focus on developments affecting land use beyond the local jurisdiction in which they are built. These developments and their impacts should be reviewed by state or regional land use agencies before construction begins.

Mining and Energy Facilities

Sweetwater County, Wyoming used to be a railroad and coal mining town. It even had limited agriculture and sheep grazing, though the local climate is dry.

After World War II Sweetwater suffered from the national decline of railroading. Seventeen hundred Sweetwater residents were employed by the railroads in 1950; only 300 are so employed now. In the sixties, however, growth

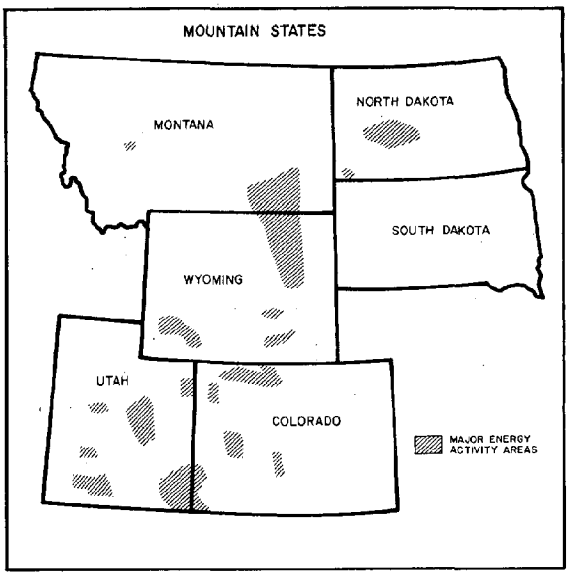
(left) Lake Sebago, Maine. A multi-purpose recreation area that has induced substantial development nearby.

picked up, starting with the construction of the large Flaming Gorge Dam. Trona mining (which produces industrial soda ash) steadily grew and oil and gas production expanded.

By 1973 Sweetwater was in the throes of an industrial boom. Its mining projects were augmented by the construction of the Jim Bridger Power Plant, which required more labor and boosted the population growth rate to an annual compound rate of 20%. Construction employment was 400 in 1970; in 1975 it is more than 4800 and growing. Mining employment has gone from 1500 to 2600 in the same period. Total population in 1970 was about 18,000; today it is 37,000; projections for the early 1980's go as high as 89,000.

This unprecedented growth has caused a crisis. It has degraded the quality of life for county residents, reduced productivity and caused higher costs in industry, and caused a breakdown in local government's ability to provide public services. There is insufficient housing, and unplanned mobile home neighborhoods are proliferating outside city limits to avoid wastewater control regulations. The number of doctors per capita has fallen to one doctor per 3,700 residents and rates of alcoholism, broken homes, and suicides are up. Schools are insufficient, and retail and service facilities lag behind demand. In coming years, the problems are expected to get worse rather than better since the industrial firms have made irrevocable commitments to expanded production, and increased coal mining is likely to occur as a further response to national energy needs.

The United States is intent upon increasing its energy self-sufficiency and it has become an explicit national policy to encourage increased exploitation of native fuel supplies. We may expect more boom towns like Sweetwater.



Energy development generally requires vast construction/extraction programs, but these programs last only a limited number of years in a specific place. Employment booms and declines. The employment boom is highly disruptive, since it upsets local wage structures in unrelated occupations such as agriculture. Agriculture is especially vulnerable in strip mining regions, where direct conflict exists between surfaces uses (agriculture and ranching) and the extraction of minerals below. Furthermore, local workers have a difficult time finding new employment in construction work since they seldom have the necessary skills; many new jobs are taken by outside labor, often producing bitter social conflict and even raising unemployment during construction.

When the boom is over, unemployment becomes a major problem. After the power plant is built or the local coal seams exhausted, many workers leave; the original residents and some new people remain, but the previous employment structure often cannot be revived to support them.

(above) Source: U.S. Environmental Protection Agency.

The major companies which embark on these projects are attracted to the local area by physical resources and to a certain extent are captive to the local town. In several communities which have absorbed major power plants, local property taxes have been eliminated while relatively luxurious community facilities have been funded at company expense. In the long term this windfall may have drawbacks. The town may act as a magnet for retired elderly people or for second home development. Thus, many community residents will have low incomes or will contribute to the local economy only on a seasonal basis.

Communities have a difficult time controlling the impacts of mining and energy-related infrastructure. These industries locate in rural areas, where the prospect of fast wealth is often irresistible; the inevitable negative impacts are ignored. Even if the potential negative impacts are recognized, the communities often do not have the resources to deal with them, because this requires huge public infrastructure investments before the development occurs and before there are any tax revenues from the new construction. Some local groups, however, have been able to exert an influence over large developments, forcing the incoming firms to make provisions to abate the major economic and environmental impacts typical of the projects concerned.

Dams and Flood Control Facilities

Before 1955, the Green River Valley near Seattle was mostly farmland. The river frequently flooded, leaving rich alluvial soils for farming but also creating a small amount of flood damage. In 1955 the Corps of Engineers built the Howard Hansen Dam to remove this "problem," and projected annual benefits of about a million dollars. However, a close reading of the Corps' figures revealed that two-thirds of these benefits were for new industry which would develop because of the flood protection. Many of the valley residents wanted neither the dam nor the industry.

Highways and sewers have been built since the dam, and urbanization has followed. Without the flood control profitable development would not have been possible, and the area might still be farms.

The dam did not even solve all the flooding problems. The soils in parts of the area are relatively impervious and drainage is slow; ponds form for a time after the snow melts. In the past, some farmers have built culverts or ditches to drain their land. The Soil Conservation Service wants to build $36 million worth of channels to solve the ponding problem, which presently costs $325,000 in damages per year. Major new development would be required to make this investment economically reasonable.

This project may or may not get built. The area is taking initial steps towards comprehensive planning and control of development, and these efforts should start with decisions about flood management infrastructure.

Flood control dams, stream channelizations, levees, and similar investments can have a major impact on development by reducing the damage from floods in an area. In the Green River basin, flood control was the first infrastructure required for development, and further flood control investments will lead to more urbanization.

Elimination of flood hazards typically has important effects on development. Dams allow development in flood plains with less risk, especially when federal insurance and disaster relief programs compensate residents for losses should a flood ever occur. Improved drainage of wetlands lets them be de-

veloped without major problems in basement flooding, lawn upkeep, or sewer infiltration.

Protected flood plains and drained wetlands are very attractive sites for development. Flood plain land is generally flat and requires little clearing. Drained marshland may require some fill and grading, but this is relatively inexpensive. In either case, the infrastructure creates ideal land for low cost development and developers are attracted.

There are both economic and environmental impacts from flood area development. Most of the benefits from dams are in protection from flood damage. However, should an uncontrollable flood ever occur, and ultimately it will, damage in developed flood plains will be very costly. Dams and channels also tend to fill up with silt, and expensive maintenance may be required. Sewers in areas with high water tables may receive a great deal of infiltration, lowering effective plant capacity. Development of wetlands can greatly reduce the groundwater available or change its quality, which may damage community water supplies.

Control of the impacts of flood investments can be very simple. If the dam is not built, there will be no maintenance costs, and though it will still be necessary to control development in the flood plain, the demand for development will be greatly reduced. Flood plains and wetlands are sensitive areas, and the zoning of flood plains to allow only suitable types of development is a proven technique.

Since flood controls have extensive and essentially irreversible consequences, they should be undertaken with care. The assumptions made in calculating the net benefits expected should be consistent with community desires and plans for growth.

Further Sources

Many of the sources about land development, such as those listed in Chapter 1, relate here as well. The major examples and experiences were drawn from several sources.

The Dallas/Fort Worth example was based on past work at USR&E for the project "Development of Airport Legislative Innovations", done for the Federal Aviation Administration. Disney World was described based on articles in *Architectural Forum* by Peter Blake and in the Orlando *Sentinel.* The Green River and Boeing case studies came from unpublished research in the Green River area, and the Sweetwater material from the Denver Research Institute study, *A Growth Management Case Study: Sweetwater County, Wyoming.*

The annual reports of the Council on Environmental Quality (1971 to 1975) also contain a great deal of useful information on growth and land use and their reports on leisure home developments are useful in analyzing the potential impacts of recreational developments. Clawson's book on *The Economics of Outdoor Recreation* is a classic and probably the best first source for ideas on predicting demand. There are few classic works on energy facility impacts, flood control and development, or rural employment growth. There are many sources, but little good synthesis has been done. The best first step is probably to start with a good bibliography and a research library, and unearth the many sources available.

Appendix

General Data and Research Sources

Data Sources

The National Environmental Policy Act (NEPA) requires environmental impact statements to be prepared for most projects having federal involvement, and many states have similar requirements for large projects. The EIS usually contains extensive data on the investment itself, and projections of population, employment, and land use. It may be a major source of information and maps.

Regional planning agencies are another good source for maps, projections, and information about local and regional growth.

The Chamber of Commerce may have information on commercial and industrial construction trends.

State agencies such as the State Geologic Surveys will know about soil types, flooding, marshes, and sensitive areas where major environmental impacts are likely. Local conservation commissions or citizen groups may also have these data, and the U.S. Geologic Survey and Soil Conservation Service may be helpful.

Another resource often left untapped is the academic community. College faculties may know what research has been done and may be able to suggest simple ways to answer important questions. There may also be students who would like to work on analyses for course credits.

Research Sources — Reports

There is a wealth of published material on almost any land use question. Some of these were described in each chapter; others are likely to be suggested by people talked to or from bibliographies in the references. Here are a few useful addresses and pointers.

- Council of Planning Librarians,
  Box 229
  Monticello, Illinois, 61856

CPL Bibliographies are available on a large number of topics related to planning, land use, and the environment. Write for a list.

- Superintendent of Documents,
  Government Printing Office,
  Washington, DC 20402

The source for non-technical government publications and many technical ones. Branch government bookstores are in twenty-five major cities, and there is a monthly catalog available.

- National Technical Information
  Service, Springfield, Virginia, 22161

NTIS is the major source for technical publications developed by or for the government and publishes comprehensive monthly and annual indices containing abstracts and organized by subject, author, issuing agency, etc. Most useful reports are in a publications (PB) series (with order numbers like PB-235-257), and response is quicker if you order by number rather than by title. Response is also quicker if payment is enclosed — microfiche copies are all $2.25 (printed copy prices depend on the number of pages). Write them for further information.

- The Transportation Research Board publishes reports about highways, airports, and mass transit. Write to them at 2001 Constitution Avenue, N.W., Washington, D.C., 20418.
- The Environmental Protection Agency has a central library in Washington and regional libraries in Boston, New York, Philadelphia, Atlanta, Chicago, Dallas, Kansas City, Denver, San Francisco and Seattle. They have a wealth of material, and the libraries can borrow from each other as needed.
- The Council on Environmental Quality, which funded this work, has also supported a number of other studies on land use. CEQ publishes an annual

report, with a section concerned with land use management and public investment. They are located at 722 Jackson Place, N.W., Washington, DC 20006.

- If you need the address or source for any government agency or publication, try your Congressman.

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